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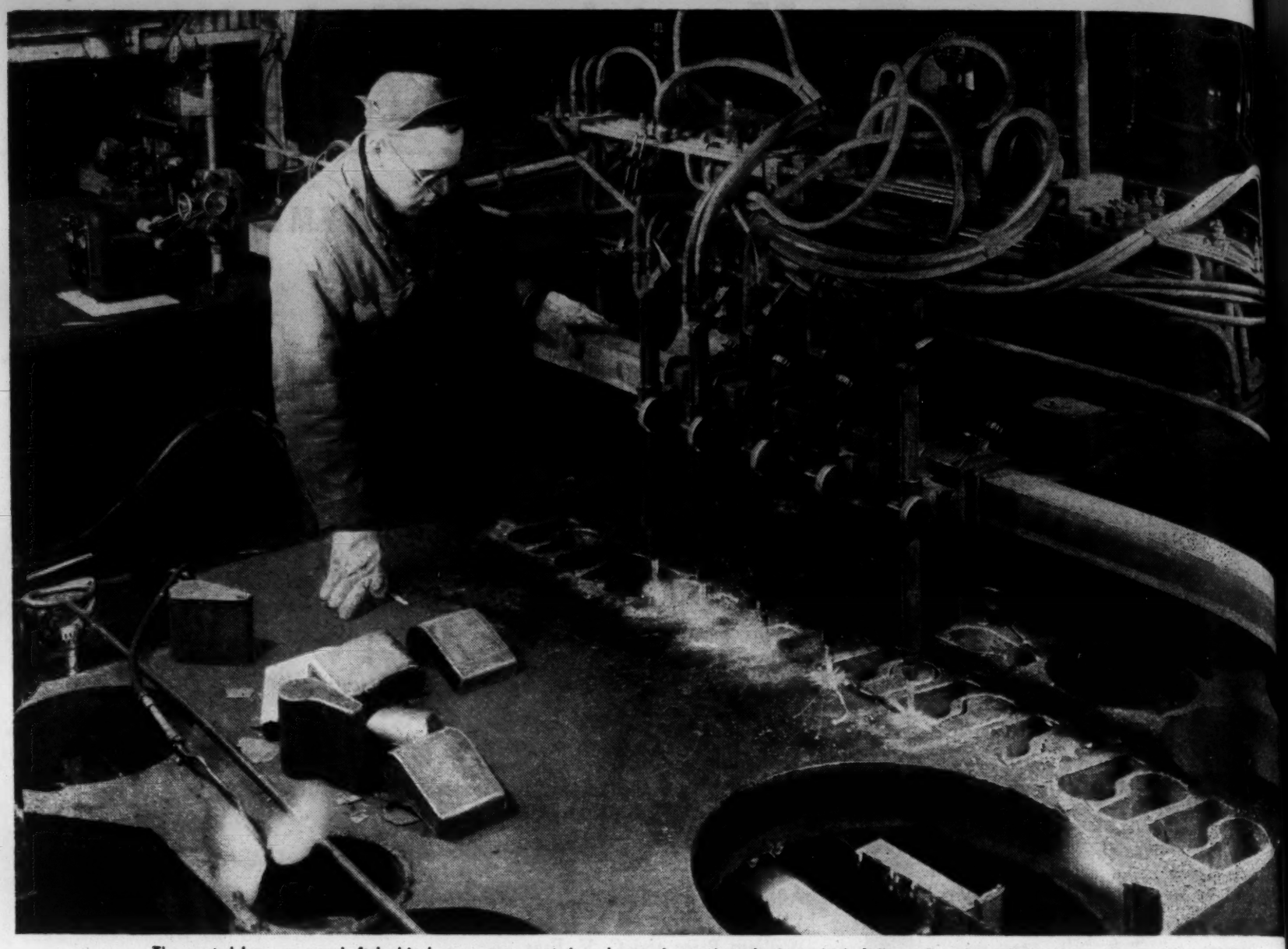

The metal box, upper left behind operator, contains electronic tracing device which follows sketch and guides cutting torch.

New Electric Eye Machines Speed Ryerson Cutting Service

The multiple-torch gas cutting machine shown above is one of eleven recently installed in Ryerson plants from coast to coast. Equipped with an electronic eye tracing device, these remarkable new machines cut the most intricate shapes swiftly, accurately. Time spent in preparing wood and metal template making is eliminated. Instead the electric eye follows a simple sketch or blueprint within plus or minus fifteen-thousandths of an inch!

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News Digest

Metal Show Attracts Record Crowds in Cleveland

The annual Metal Show held dur-g the week of October 17 at the ublic Auditorium in Cleveland, hio, was one of the most successful history, at least from the stand-oint of attendance. A 40,000 at-ndance was predicted, but this figure as exceeded in the first three of the ve days. Many exhibitors reported at a fair percentage of those visit-g the show displayed genuine in-rest in displays or sought specific nformation.

In a show as large as this one, hich was spread over a vast area as as presented by Cleveland's Public uditorium, it is difficult to look ack and pick out any one outstand-g development to cite as the one oint of interest in the show. How-ver, several trends were apparent, ncluding the use of displays in which ome action takes place. The reason an be seen in the fact that welding, asting and finishing displays where ome actual operation was going on never seemed to be lacking for in-terested spectators.

This year the latest metal—ti-tanium—went on exhibit for the first time. Two or three industry booths, as well as one of the U.S. Armed Service displays, showed metallic ti-tanium in any one of several forms, including tubing, forgings, sheet and the metallic sponge developed in the early stages of converting the ore into usable metal. Since, with the excep-tion of government uses, titanium has only been applied experimentally up to this point, little could be told about actual service characteristics of the metal. Many people who had only heard of titanium were, however, given a chance to see and feel the metal that could well be the most important metal of the coming gen-eration.

Judging by the number of displays and the interest shown in the dis-plays, precision parts are due to receive considerable attention from industry in general. Innumerable dis-plays were devoted to die castings, precision castings made by both "lost" wax and frozen mercury methods, metal powder parts, and other parts which require little or no machining or finishing before use.

In addition to the small castings or formed parts previously referred to, there were numerous other casting displays. Although malleable and gray iron casting were presented by the displays of their respective foundry societies, many individual foundries took display space to show castings being produced for special service re-quirements. Primarily, such castings were for either heat or wear resis-tance, or both.

In the field of welding, most atten-tion was given to new developments in the use of inert gas-shielded arc welding. Several displays featured this method, including that of an alumi-num company making souvenirs in its booth. Outstanding development in this field is the extension of a gun-welding method to permit its use on aluminum plate up to 3 in. thick. The same method is also extended to ferrous metals. Unlike earlier inert-gas welding methods, the new method makes use of an expendable electrode which is fed in wire form through the gun.

Heat treating, particularly those methods which accomplish their heat-ing function quickly, likewise came in for considerable attention. New salt bath methods vied with induc-tion heating and high-speed gas heat-ing for prominence. This year's show probably saw more induction heating equipment than at any previous show.

The Army Ordnance Department showed examples of shells which had been produced by cold extrusion. The cold extrusion method had been de-veloped by the Germans for use in World War II. Soon after peace, American investigators picked up the process and have been successful in extending the process way beyond the low carbon steels to which it was limited in Germany.

As far as metals are concerned, the Metal Show is still only partially representative. While most of the nonferrous metals were represented by one or more exhibitors, steel pro-ducers were conspicuous by their absence. With the exception of a few specialty steel companies showing their wares, there was only one steel exhibit, and that was of a distributor showing a remarkable new free-ma-chining steel.

Next year's show has been sched-uled for Chicago, Ill., the scene of the 1947 show.

Cavitation Corrosion Attributed to Microcells in Metal Crystals

In a recent investigation of cavi-tation corrosion, G. Petracchi (*La Metallurgia Italiana*) found that cavi-tation is initially destructive, not be-cause of the mechanical stresses to which it gives rise, but because these stresses are associated with a corrosive action primarily due to electrical effects.

Corrosion due to cavitation, a phe-nomenon for which various theories have been preferred, occurs in marine propellers, hydraulic machines, con-densers, etc. It is characterized by the liquid detaching from, then imping-ing upon the surface of the metal. This action is accompanied by forma-tion of vacuum pockets in the liquid, liberation of gases normally dissolved in the liquid, and local corrosion of the metal.

In this phenomenon, the metal can operate as an anode and as a cathode. The electric currents are generated by microcells set up in adjacent crystals as a result of alternating mechanical stresses and the motion of the liquid.

Further investigations on this prob-lem are being conducted.

Zinc, Cadmium, Tin Deposited on Aluminum by Chemical Process

A new process for depositing zinc, cadmium and tin by chemical displacement upon aluminum was the subject of a paper published in *Metal Industry* (Sept. 23) by S. Heiman.

A dilute hydrofluoric acid dip was used to remove gross oxide and to activate the surface of the aluminum preceding the immersion dip. The film remaining on the aluminum after the cleaning treatment can be removed by dissolving in 70% (by volume) nitric acid at room temperature and rinsing in cold water.

Immersion solutions contain the metal sulfate, hydrofluoric acid or the fluoride ion, and various addition agents. For zinc, 0.5N acid concentration was used and immersion time was not critical, 30 to 60 sec. giving best results. Temperature should be kept between 68 and 77 F. Aluminum alloys successfully plated by the zinc immersion process are 24ST, 52S and 61ST.

In cadmium deposition, good agitation of the aluminum was found necessary to produce deposits of uniform, sound structure, and time of dip was more critical than with zinc, ranging from 5 to 15 sec. Good agitation and careful attention to optimum dip time were also found essential to successful tin deposition. The lower the stannous sulfate and the higher the hydrofluoric acid concentrations, the shorter the time for good tin deposits. In general, the maximum immersion time is about 10 sec.

All deposits were tested by their success in holding copper plates. Best results were obtained with zinc immersion coatings, although a special cyanide copper strike on the zinc prior to plating from the copper pyrophosphate bath was found necessary. The range of metal sulfate-hydrofluoric acid concentrations in which adherent copper deposits were obtained was much smaller with cadmium immersion coatings than with zinc. However, the results were much better with this system than with the cyanide cadmium solution. A wide range of tin immersion concentrations appears feasible, and these deposits are superior to those obtained from the stannate bath as bases for further plating.

Cracking of Aluminum Alloys During Welding Investigated

A step toward a practical solution to the problem of cracking during the welding of aluminum alloys is described by W. I. Pumphrey in *Metallurgia* (Sept.). The work described in this paper was carried out by the University of Birmingham and sponsored by the Aluminum Development Association.

Pumphrey and his associates analyzed mathematically the conditions governing the occurrence of cracking at temperatures above the solidus in a straight butt weld between two parallel and restrained sheets of an aluminum alloy. From this analysis they developed a method of estimating the effect of changes in physical properties of aluminum or in welding technique upon weld cracking.

Cracking appears to be increased by increases in (1) brittle temperature range of the metal in the weld pool, (2) rate of cooling of the solidifying weld metal, (3) speed of welding, (4) degree of restraint imposed on the abutting sheets during welding, and (5) thermal conductivity or linear coefficient of thermal expansion of the aluminum alloy. It is possible to decrease the brittle temperature range of the metal in the weld pool by welding the base metal with a filler rod of the same alloy series but of higher alloy content, and possibly containing a small amount of some addition specifically designed to reduce the crystal size of the metal in the weld bead.

Cracking at temperatures below the solidus does not generally occur in welds because of the low stresses to which they are subjected during cooling. When present it may be decreased by (1) ensuring adequate ductility in the metal to be welded, (2) designing the form and welding technique to minimize restraint and stress-raising effects, and (3) reducing cracking at temperatures above the solidus. Fine cracks formed above the solidus temperature may initiate cracking below the solidus when metal contraction is restrained. In general, however, cracking above and below the solidus are two separate problems and may or may not occur together.

Oxygen, Nitrogen Penetration in Zirconium Sets Heating Limits

Practical limits for the heating of zirconium in air, oxygen and nitrogen and the possibilities of producing hard surface coatings on zirconium have been explored by E. T. Hayes and A. H. Roberson of the U. S. Bureau of Mines (*Journal of the Electrochemical Society*, September).

Gain in weight data and metallographic examination were used to establish temperature limits for zirconium in various atmospheres for appreciable periods of time. Limits obtained are 1470 to 1650 F for normal air, 1470 F for dry oxygen, and 1650 to 1830 F for dry nitrogen. It is apparent that absorption of nitrogen by zirconium occurs at a much slower rate than absorption of oxygen. It is also evident that the absorption of these impurities passes safe limits in the range 1650 to 1850 F. This increase in penetration is believed to be connected in some way with the allotropic transformation from alpha to beta zirconium at 1584 F.

Surface hardness values close to Rockwell C 65 can be attained by heating in dry air, oxygen or nitrogen at elevated temperatures. The hard films can be produced by heating 1 hr. at 1470 F in oxygen or dry air, or 24 hr. at 2190 F in dry nitrogen. The oxide surface retains its hardness without flaking for a few hours' exposure at 1110 F in air, but the nitride coat is somewhat brittle and would be restricted to use in air at temperatures below 750 to 930 F. The voluminous nature of the oxide formed by decomposition of the nitride in air suggests that nitrogen, as well as oxygen, is involved in high-temperature corrosion in air. The hard oxide coats appear to have better bonding and stability in air, as well as grain size control; potentially, they have much wider application.

Patents Granted on Ductile Cast Iron

Two patents on ductile cast iron have been granted to International Nickel Co., according to an announcement made before the Gray Iron Founders' Society annual meeting. At the same time, Inco stated that more than 40 companies are licensed to produce the new iron. The iron has greater strength than ordinary cast iron, plus greater ductility and shock-resistance.

Advances in Gray Iron Are Discussed at A.S.T.M. Symposium

The current high interest in gray iron as an engineering material was demonstrated last month by the Cast Iron Symposium held at the A.S.T.M. First Pacific Area National Meeting in San Francisco. The four papers presented there were highly informative, and taken together they gave an over-all picture of the properties and uses of gray cast irons and a view of recent developments in the field.

The paper by C. K. Donoho, American Cast Iron Pipe Co., entitled "Mechanical Testing and Properties of Gray Cast Iron," presented typical tensile test data for gray irons in the 20,000 to 60,000 psi. class (A.S.T.M. Spec. A48-48).

The correlation between the hardness and strength of a gray iron casting was demonstrated, and it was brought out clearly that a much better correlation is possible if the gray irons are inoculated previous to casting. It was also shown that impact values closely follow resilience of a given iron, *i.e.*, the area under the stress-strain curve in transverse testing, and that compressive strength of gray iron correlates very well with Brinell hardness.

In the testing of nodular iron, Mr. Donoho said that the use of a keel block specimen was considered mandatory if the full tensile values possible with this material are to be developed. The tensile-hardness relationship for nodular iron more nearly approaches steel than gray iron, and most nodular irons possess tensile strengths intermediate between that of steel and flake graphite gray iron.

Mr. Donoho concluded that, as would be expected, either increasing section size or increasing carbon equivalent tend to lower the strength values and hardness of gray iron. Inoculation produced irons more consistent and predictable as concerns physical properties than uninoculated irons. The high ratio of tensile strength to hardness following such treatment produces maximum toughness measured by impact testing. As concerns nodular graphite irons, their properties were believed to be best measured by using a transverse test with a complete stress-strain curve or by the use of tensile specimens made from keel block coupons. Nodular graphite gray irons, although having tensile strengths considerably higher than the usual flake graphite irons, exhibit a compressive strength-Brinell ratio very similar to normal flake graphite iron.

The paper, "Automotive Cast Irons, Including Brake Drums," by R. G. McElwee discussed in some detail automotive irons, both as used in miscellaneous castings, cylinder blocks, brake drums and clutch plates. It is obviously his feeling that relatively high carbon irons should be employed whenever possible because of the decreased shrinkage, easier castability, and high machinability of such irons as compared to lower carbon types. Similarly, he observes that a 35,000-psi. iron of known and proven soundness is often to be preferred in many applications to a higher strength iron with a greater tendency to defects or porosity at junctions of light and heavy sections. High carbon becomes a must in the case of materials such as brake drums that are required to resist heat checking. When higher strength is required in such applications, he feels it should be obtained through the use of alloying elements rather than by reducing total carbon content.

The unique properties of gray iron that make it an essential component in some 150 basic industries were discussed in the paper "Applications and Uses of Gray Iron Castings, Including Significance of Various Properties of Gray Cast Iron," by C. O. Burgess, Gray Iron Founders' Society. It was pointed out that the large number of existing specifications for gray iron is evidence of the wide application of the material in industry.

In addition to the mechanical strength and rigidity possible with gray iron, its high castability, unusual wear resistance, corrosion resistance, machinability, damping capacity, freedom from notch sensitivity and ability to harden without distortion, are of fundamental importance in its wide commercial application. Included in this paper was a review of progress in the use of gray iron at elevated temperatures and a record of the recognition so far obtained from the A.S.T.M. and the A.S.M.E. Boiler Code Committee relative to extending the permissible temperature ranges within which controlled gray irons can be employed.

Nodular graphite gray iron was also briefly considered, and it was pointed out that the great strength, ductility and high modulus of elasticity of nodular irons will eventually extend the engineering applications of gray iron very materially but will require a new set of specifications.

The future status of gray iron and the means of rendering the product increasingly valuable to industry were considered. The future appears to be bright in view of the fact that the casting process itself is unique as concerns effective metal placement; gray iron is generally accepted as the most economical of existing metals as concerns unit cost; and last, gray iron possesses the unusual combination of essential engineering properties just described. Because of its widespread character, however, coordinated efforts through technical societies and the trade association of the gray iron industry will be necessary to assure its continued advance and development to meet modern engineering demands.

The development of specifications in the gray iron field was covered by H. Bornstein, Deere & Co., in his paper "Development, Significance and Uses of Specifications for Cast Iron."

He noted the striking revisions that have been necessary in the last 30 years to keep track of the advances in this field. This is particularly true in regard to higher strength classes of iron (up to a 60,000 psi. minimum tensile strength). He also emphasized the uses and abuses of specifications. Specifications, for example, can promote improvement in the product and research directed towards future improvement as well as mirror advances in the industry. One of the abuses of specifications is to insist on higher strength materials than are required for a given application, with the result that there is an unjustified increase in cost of production, and properties such as machinability suffer. Despite occasional abuses, it was observed that specifications for gray iron serve a definite need in industry and can be intelligently used to obtain maximum performance with economy.

In the discussion following the papers, a considerable amount of interest was shown in the nodular gray irons, briefly mentioned in two of the papers. This interest was directed towards the best type of nodulizing alloy, methods of adding magnesium or the nodulizing alloy, and the potential importance of such irons in the whole metallurgical field.

Reported by C. O. Burgess, Technical Director, Gray Iron Founders' Society, Inc.

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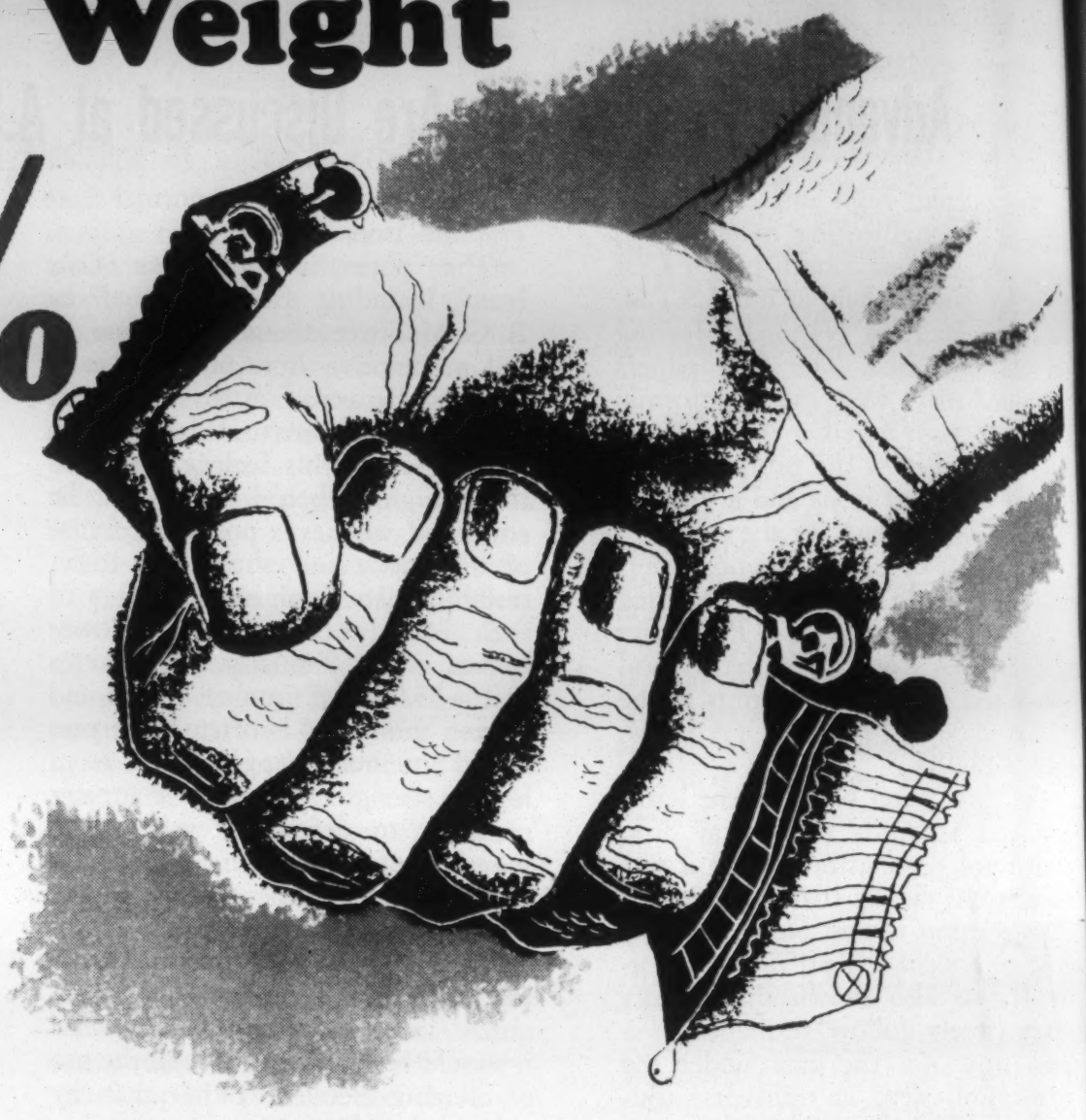

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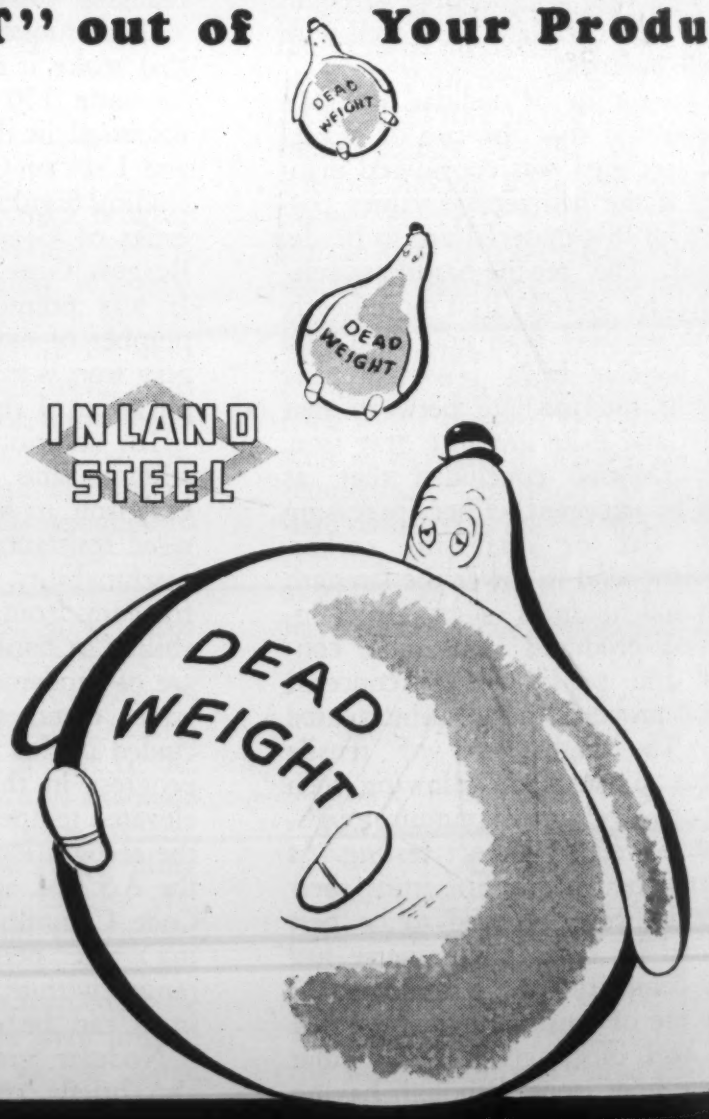

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Materials & Methods
NOVEMBER 1949

How Plastic Deformation Influences Design and Forming of Metal Parts

Part 1-True Stress-Strain and Initial Plastic Flow

Here is a clear and simple explanation of plastic flow in metals and how application of knowledge gained to date on the subject can be used to advantage in the design and production of metal products.

by JOHN R. LOW, JR.,
Research Laboratory, General Electric Co.

• THE WIDE USE of metals as engineering materials results not only from their mechanical strength and other service properties, but also from the fact that metals can be deformed plastically. That copper possesses a high electrical conductivity would be of considerably less importance if copper could not be rolled into rods and drawn into wire. Similarly, the desirable magnetic properties which can be developed in certain of the iron-silicon and iron-nickel alloys could not be used to their full advantage in many applications if we were limited to melting and casting as the only available methods of fabrication.

In spite of the tremendous importance of plastic flow in metals, the knowledge that has been gained about it and the factors affecting it is still not being applied as widely in actual practice as it might be. This is perhaps largely due to the fact that engineers and production people are still not sufficiently acquainted with the developments in this field. Therefore, the purpose of this and the succeeding article is to explain as simply as possible the fundamental principles of plastic deformation and how the principles can be applied to solving design and production problems.

Fundamentally, the ability of metals to deform plastically, *i.e.,* to suffer a permanent change in shape without rupture, is related to the structure of the metallic crystals and to the nature of the binding forces between the metal atoms in these structures. In general, however, the dimensions of the individual crystals are so small compared to the over-all dimensions of the pieces of metal with which we have to deal that we can, for many purposes, disregard their crystalline nature. Therefore, in the discussion of plastic deformation which follows we shall for the most part treat the metal as an isotropic, homogeneous body.

Some Definitions

How a metal behaves mechanically is conveniently described in terms of the observed relation between stress and strain when the metal is subjected to external forces. In the tension test, for example, we apply a continuously increasing load to one end of a cylindrical bar with the other end fixed and observe the change in length of the bar. The numerical value of the load at any instant divided by the cross-sectional area of the bar at the same instant is the *stress* applied to the bar. The observed increase in length of the bar, or of a particular gage length marked on the bar, divided by the original length is the longitudinal *strain* in the bar.

By making simultaneous observations of the load and the length of the bar during the test, we obtain a *load-extension* curve for the material. This load-extension curve is very commonly, but erroneously, called the stress-strain curve for the material. It is more accurate to refer to it as the *nominal* stress-strain curve. During the early part of the tensile test when the strains are small and the dimensions of the test bar have not changed greatly, no great error results if the stress is computed by dividing the applied load by the original cross-sectional area of the bar. If, however, the length of the bar increases appreciably, the cross-sectional area supporting the load is correspondingly reduced and the *true stress* will be considerably higher than that computed if the original area is used for the computation. Similarly, in computing the strain from the observed increase in length of the bar, it is satisfactory to compute the strain by dividing the increase in length by the original length, when the strains are small. For large strains, however, it is essential that each increment in length be divided by the length of the bar just before the increment occurred if we are to avoid distortion of the stress-strain curve.

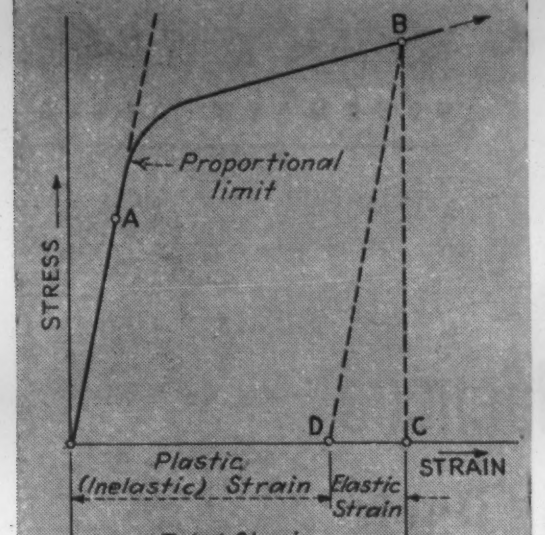


Fig. 1—Initial portion of stress-strain curve (Gensamer).

The strain computed in this manner is called the *true-strain* or *natural strain.* These alternative methods of computing stress and strain in the tension test are shown below:

$$\text{True stress} = \frac{P}{A}$$

$$\text{Nominal stress} = \frac{P}{A_0}$$

$$\text{True strain} = ln \frac{l}{l_0}$$

$$\text{Nominal strain} = \frac{l - l_0}{l_0} = \frac{l}{l_0} - 1$$

P = load; A = actual area after straining; A_0 = original area; l = actual length after straining; l_0 = original length; ln = natural logarithm.

Table I will serve to give some idea of the magnitude of the differences between these two methods of defining stress and strain.

Stress-Strain Relations for Metals

In Fig. 1 is shown the initial portion of the stress-strain curve for a typical metal. The first part of this curve is a straight line, *i.e.,* the strain is directly proportional to the applied stress. Furthermore, in this portion of the curve the material is elastic; for example, if the stress is increased to point A and then decreased to zero, the specimen will return to its original dimensions. At some higher value of stress the curve begins to deviate gradually from the original straight line at a point called the *proportional limit.* The *elastic limit,* that is the stress required to produce the first detectable permanent increase in length, is generally very nearly the same as the proportional limit. If, at any point on the curve beyond the elastic limit, for example Point B, the load is removed, the specimen will contract elastically but will not return to its original dimensions. The amount of permanent deformation which has occurred is the *plastic strain.*

The curve shown in Fig. 1 is typical of most nonferrous metals and of many steels; but steels in general, particularly when in the annealed or normalized condition, exhibit a *yield-point* rather than the gradual type of yielding. The *yield-point* is characterized by a drop in load at the beginning of plastic deformation and a considerable extension at substantially constant load as shown schematically in Fig. 2. The stress at the point marked Y' is called the *upper-yield-point;* that between points B and A the *lower-yield-point;* and the elongation occurring between points B and A the *yield-point elongation.* During the extension at substantially constant load in the tension test the deformation does not occur uniformly along the length of the specimen. Deformation proceeds by the formation of discrete bands of localized deformation which then spread out along the length of the specimen. These regions of localized flow are known as "Lueders-Lines," and they will continue to form and increase in width as the specimen is elongated until all of the specimen has been deformed in this manner. At an average extension corresponding to Point A in Fig. 2, the entire length will have been deformed in this manner and from this point to the maximum load, deformation is uniform throughout the length.

The magnitude of the yield-point elongation and the depth of the surface markings associated with inhomogeneous yielding of this type varies considerably in steels, depending upon the composition and heat

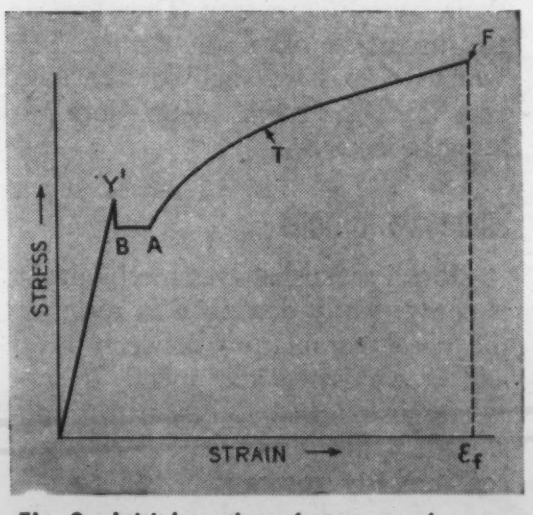


Fig. 2—Initial portion of stress-strain curve of a metal with yield point (Hollomon).

treatment. It is most marked in steels containing large amounts of free ferrite such as the lower carbon grades of sheet steel, where yield-point elongations up to as much as 5.0% may occur. This peculiar type of initial yielding behavior is responsible for the formations of "stretcher-strains" in the deep drawing of steel sheets and for "fluting" or "panelling" in bending flat rolled steel products.

Thus far we have limited the discussion of mechanical behavior of metals to the elastic portion of the stress-strain curve and to the very early stages of plastic deformation. In this region no distinction need be made between the nominal stresses and strains and the true stresses and strains. As deformation proceeds, however, the dimensions of the specimen begin to change appreciably, and a distinction must be made if the stress-strain curve is to serve as an accurate description of the mechanical behavior of the material.

Fig. 3 is a comparison of the nominal stress-strain and the true stress-strain curves for 0.05% carbon steels. The nominal stress-strain curve would indicate that at first an increasingly higher stress is required if plastic deformation is to continue; the stress required to cause plastic deformation finally reaches a maximum, and beyond this maximum deformation proceeds even though the stress is decreasing; and that finally fracture occurs when the stress has fallen to a value very much below the maximum. The true behavior of the metal is actually quite different. In the true stress-strain curve of Fig. 3 we see that the metal actually strain-hardens in a perfectly regular manner, the rate of strain-hardening decreasing continuously up to the point at which rupture occurs. The rupture stress in this case is the highest *true stress* which the material is able to support.

The distorted picture of the mechanical behavior of the metal which results when nominal stresses and strains are used to describe this behavior is in part due to the fact that the phenomenon known as necking occurs in the ordinary tensile test. As a tension specimen is elongated by plastic flow, its cross-sectional area supporting the load is reduced. The increase in *stress* which results from this decrease in area is offset by the fact that the metal strain hardens and is therefore able to support a greater load despite the fact the cross-sectional area is less. However, the rate of strain-hardening, *i.e.,* the slope of the curve, continuously decreases

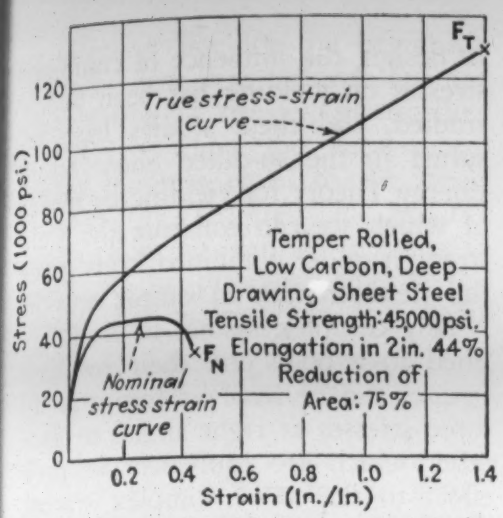


Fig. 3—Nominal and true stress-strain curves for SAE 2345.

as deformation proceeds. At some point in the test the rate of strain-hardening falls below the value necessary to offset the increase in stress resulting from the increase in load and the decrease in area. From this point on any local region which, due to inhomogeneities in the bar or in the cross-sectional dimensions, is deformed slightly more than neighboring regions can no longer "pass-on" the deformation by strain hardening, and the deformation is localized. As the test proceeds this localization becomes more marked, the cross-sectional area at one point is greatly reduced, the load necessary to continue flow in the "neck" decreases, and the specimen finally fractures.

The result of this necking is that the numerical value of the elongation to fracture in the tensile test when computed as a nominal strain, *i.e.*, the fractional increase in length of some arbitrary initial gage length, will be markedly dependent upon the initial gage length chosen. This variation of total elongation to fracture with initial gage length is shown for a number of metals in Fig. 4.

It is perhaps desirable at this point to emphasize the fact that when we have carried out a standard tension test on a piece of metal we have merely determined its mechanical behavior under one particular set of conditions. These conditions for the ordinary tension test are: (1) Uniaxial tensile stress. (2) Room temperature. (3) Average rate of deformation approximately 0.05 in./in. per min. (4) Direction of deformation unchanged during the test.

If we wish to make use of the results obtained from the simple tension test to predict the behavior of a metal under another set of conditions, we must know the manner in which a change in any one of the above conditions will influence this behavior. For example, in a structure or a machine part we seldom duplicate the first condition listed above. In general, the metal is likely to be subjected to loads applied in several directions simultaneously and we must, therefore, know how its behavior under combined stresses differs from that under a simple tensile stress. In most forming operations, such as the bending of a plate or the drawing of an automobile fender, all of the conditions will differ from those existing during the tension test.

If we knew precisely the manner in which a change in these "external" variables changed the mechanical behavior, we could then use the simple tension test to measure the mechanical properties in a fundamental way and could then expect to predict accurately the behavior under any other set of conditions. The influence of these separate variables is yet to be investigated completely and the results embodied in a general theory of plastic flow. However, considerable progress already has been made.

While a complete knowledge of the influence of the external variables (stress combination, temperature, strain rate, and direction of straining) is essential if we are to make the fullest use of the metallic materials available to us, of even greater

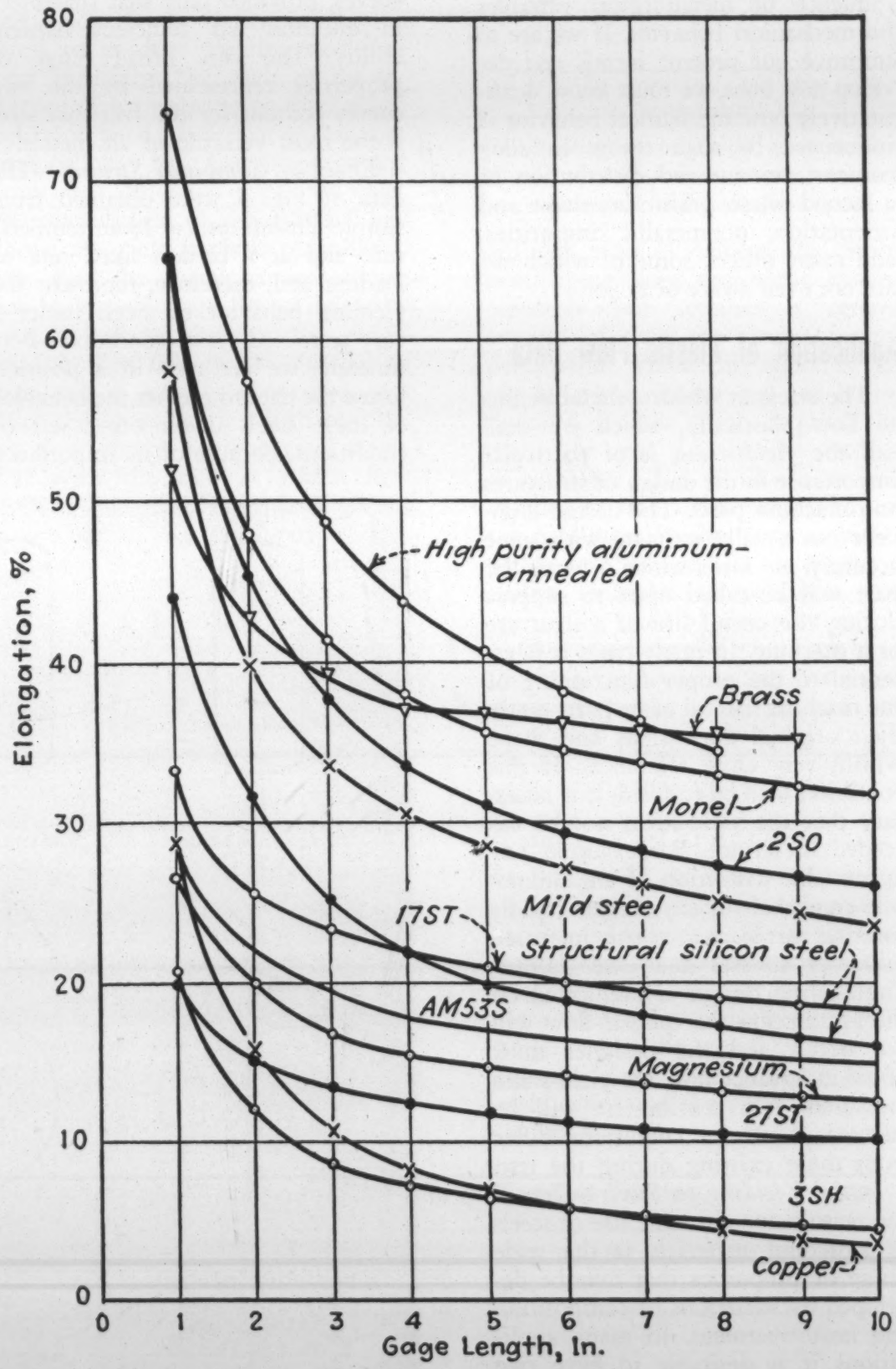


Fig. 4—Nominal strain to fracture in tension test as a function of initial gage length. (Templin & Sturm)

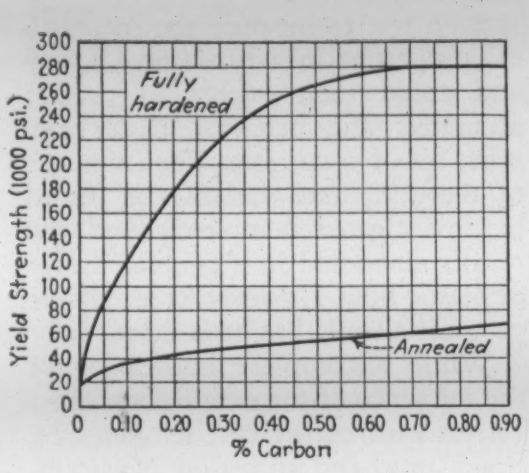


Fig. 5—Variation of yield strength with carbon content.

importance is a knowledge of the influence of metallurgical variables on mechanical behavior. If we are to improve our present metals and develop new ones, we must know quantitatively how mechanical behavior is influenced by such things as alloy content, amount and distribution of a second phase, grain size, shape and orientation, nonmetallic impurities, and many others, some of which we are not even aware of as yet.

Application of Plastic Flow Data

The stress at which a metal begins to flow plastically, which we shall call the *yield-stress,* is of particular importance in the design of structures and machine parts. The design engineer can usually estimate with some accuracy the loads which a particular part will be called upon to support during the useful life of a structure or a machine. In many cases it is essential to the proper functioning of the machine that all of its parts retain their original dimensions and shape within very close tolerances. If this condition is to be fulfilled, it is necessary that the yield-stress not be exceeded in service. For example, any appreciable distortion of an automobile crankshaft or any similar rapidly rotating part leads to greatly increased vibratory stresses and early failure. Engineering design is predicated on the assumption that plastic flow will not occur, and the designer must know in advance how the yield-stress measured in a tension-test will be affected if service conditions differ from those existing during the test.

Initial Yielding in Steels—One of the reasons for the wide use of steels as structural materials is the wide range of properties that may be developed by variations of composition and heat treatment. In many applications it is desirable to have two sets of properties in the same steel. For fabrication involving plastic deformation, such as forging, stamping, flanging, machining, etc., it is desirable to have a material with a low yield stress and a considerable degree of ductility. On the other hand, if the formed part is to be used as a load carrying member, it is desirable to have the yield-stress as high as possible. Fig. 5 shows the variation of room temperature yield-strength with carbon content for steels in the annealed condition as well as the yield strengths of these same steels in the fully hardened condition. For a given carbon content, it is possible to develop any yield-strength between the limits set by the upper and lower curves, provided only that that piece in question has sufficient hardenability. The very broad range of properties represented by the two curves account for the fact that steel is the most versatile of all metals.

Effect of Combined Stresses—The data of Fig. 5 were obtained from simple tension tests at room temperature and at a certain fixed rate of loading and, therefore, represent the yielding behavior of steels under a very restricted set of conditions. Fortunately, we are now in a position to use the data to predict the behavior of these steels under other sets of conditions. Because of its importance in design, the influence of combined stresses on yielding has been widely studied, and these studies have resulted in the so-called Shear Strain Energy Theory for yielding by means of which we can compute the yield strength under combined loads given the yield-strength in simple tension.

Any complex system of loads applied to a body and their resultant stresses can be resolved into a set of three stresses at right angles to each other which are equivalent in their effect to the more complex system. These three resolved stresses are called the *principal normal stresses* and will be designated as S_1, S_2, and S_3. If tensile stresses are considered positive and compressive stresses negative, S_1 represents the greatest and S_3 the least stress in the algebraic rather than the numerical sense. For example, for a system of loading which can be resolved into two tensile stresses and a compressive stress, the greater tensile stress would be designated as S_1, the lesser tensile stress as S_2 and the compressive stress as S_3. The principal stresses and their relative magnitudes for a number of the more commonly encountered combined stress systems are shown in Fig. 6.

The general statement of the shear-

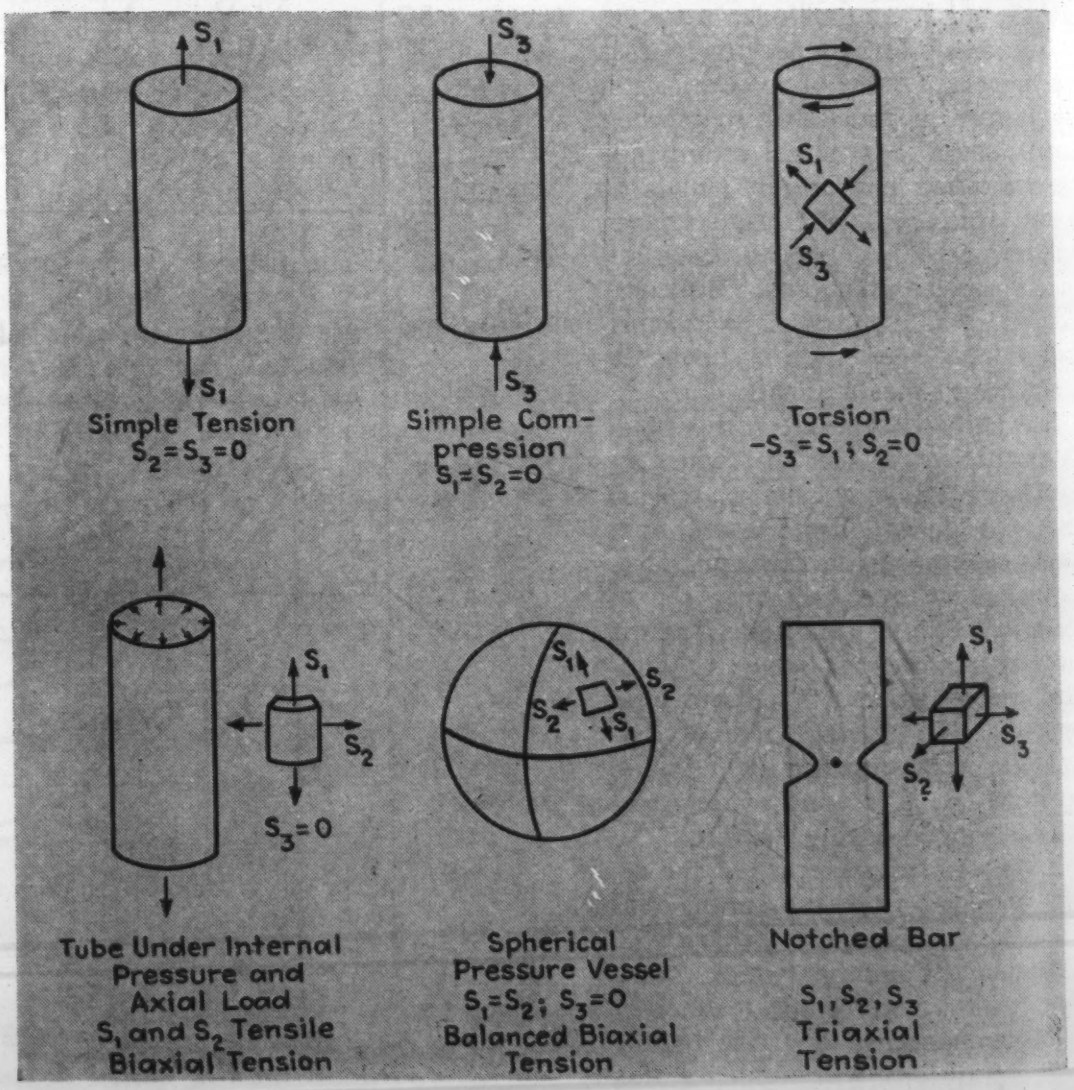


Fig. 6—Principal stresses for a number of common combined-stress systems.

strain-energy law for the beginning of plastic flow is as follows: For any combination of stresses, plastic flow will begin when the shear-strain-energy becomes equal to the shear-strain-energy required to produce plastic flow in simple tension. In terms of the principal stresses this means that plastic flow will begin when:

$$\frac{(S_1-S_2)^2+(S_2-S_3)^2+(S_3-S_1)^2}{2}=S_0^2$$

Where S_0 is the stress required to produce plastic flow in the simple tension test at the same temperature and the same rate of application of the load.

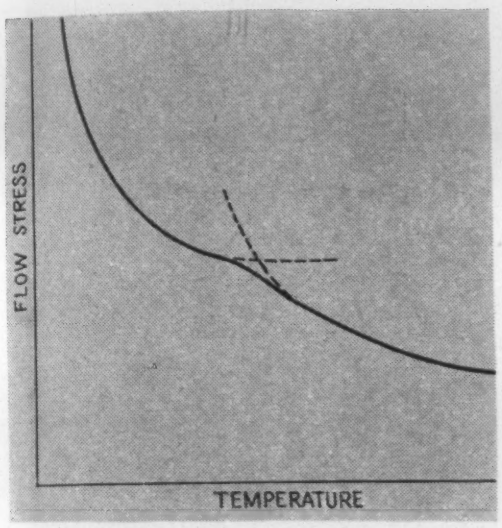


Fig. 7—Variation of yield stress with temperature for a typical steel (schematic).

For the more common case of biaxial stress systems, *i.e.,* where one of the principal stresses is zero, the above expression (for example, taking $S_2 = 0$) reduces to

$$S_1^2 - S_1 S_3 + S_3^2 = S_0^2$$

Thus, for the torsion case where $S_2 = 0$ and $S_1 = -S_3$, flow will begin when $S_1 = 0.577S_0$. For balanced biaxial tension where S_1 and S_2 and $S_3 = 0$, the theory predicts that plastic flow will begin when $S_1 = S_0$ or, since $S_1 = S_2$, when $S_2 = S_0$.

The shear-strain-energy law for the beginning of plastic flow is now widely used by engineers to determine allowable stresses under combined loads. One elementary example will illustrate the general method. Let us assume that we have a steel, which in simple tension has a yield strength of 100,000 psi., and want to know the allowable torsional stress that can be applied to a thin walled tube of this same material.

As we have seen above for the torsion case, yielding will occur when $S_1 = 0.577x\ S_0$ and S_1 equals the maximum shear stress. The maximum shear stress that can be applied to such a tube is, therefore, 57,700 psi. If it had been assumed that yielding would occur in the torsion case when the maximum shear stress reached the value of the maximum shear stress at yielding in simple tension ($\frac{1}{2}\ S_1$), the allowable stress calculated would have been only 50,000 psi.

Effect of Temperature—In general, it is observed for all metals that as the temperature is increased, the stress to produce yielding decreases very markedly. The study of the influence of temperature on mechanical behavior, particularly that of the iron-base alloys, has been approached from two different points of view. At temperatures of about 800 F and above, the yield stress is generally so low that the metal cannot sustain any appreciable load for an indefinite period without some plastic deformation. For this reason the design engineer is usually concerned, not with the stress below which no plastic flow occurs, *i.e.,* the yield stress, but with the rate at which flow occurs, *i.e.,* the "creep-rate" for a given stress and temperature combination. In this article we shall confine ourselves to the effect of temperature in the range below about 800 F.

The variation of yield-stress, with temperature, for a typical steel is shown schematically in Fig. 7. The "hump" in the curve is peculiar to steels and is caused by the phenomenon known as strain-aging or "blue-brittleness." Most steel, if strained slightly and then aged at room temperature, will exhibit an increase in hardness and a decrease in ductility. At more elevated temperatures this occurs rapidly enough so that the effect is appreciable in the short time required to carry out the tensile test. For this reason the whole of the stress-strain curve is raised, for example, when testing at 400 F at

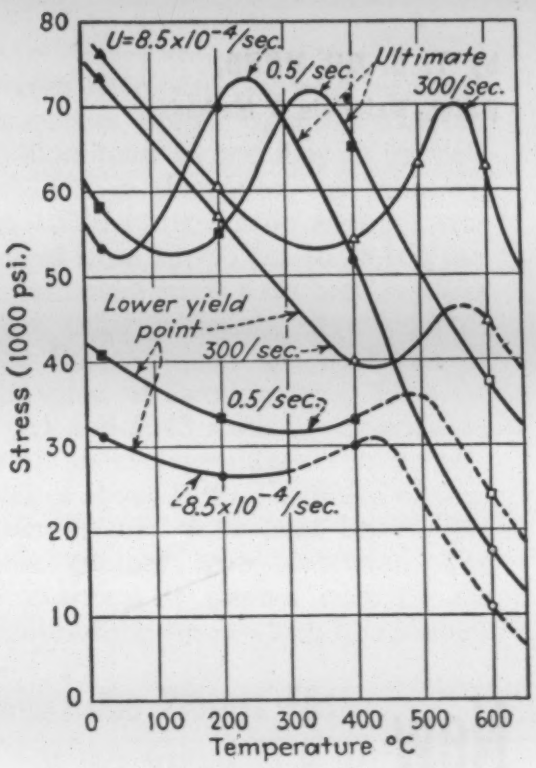


Fig. 8—Ultimate and yield point stresses of mild steel at various temperatures and rates of strain (Manjoine).

ordinary rates of deformation. Since strain-aging does not occur instantaneously but requires a certain amount of time, the range of temperature in which this effect is observed in the tension test will be influenced by the time required to make the test, *i.e.,* by the rate of deformation. Fig. 8 illustrates this manner in which the temperature of the maximum in the curve of either yield-stress or tensile strength is shifted to higher temperatures with increasing rates of deformation.

One other effect of temperature on the initial yielding is that the *yield-point-effect*—the drop in load and elongation at constant load at the beginning of plastic flow—becomes more marked as the temperature is lowered.

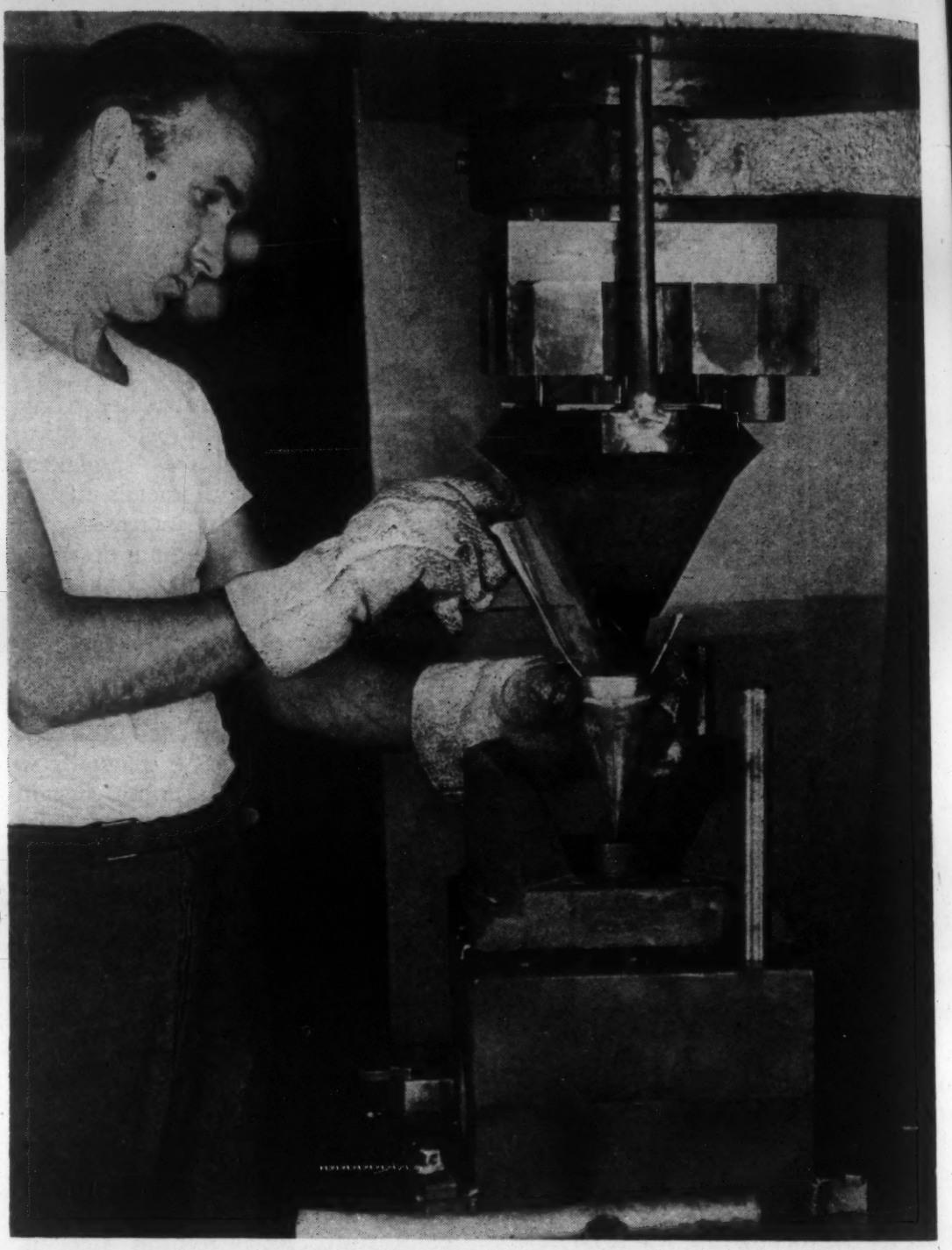
Effect of Strain-Rate—In general, an increase in the strain-rate, or rate of loading, acts in the opposite direction to increasing the temperature. An increase in speed of testing affects the yield-point behavior in much the same manner as a decrease in temperature. As the speed of testing is increased, the drop in load at the yield point and the yield point elongation both increase in magnitude.

Comparison of Nominal and True Stresses and Strains in Tension Testing

% Elongation in Tension	Nominal Stress	True Stress	Difference	Nominal Strain	True Strain	Difference
5	P/A_o	$1.05\ P/A_o$	$0.05\ P/A$	0.050	0.049	0.001
10	P/A_o	$1.10\ P/A_o$	$0.10\ P/A$	0.100	0.095	0.005
20	P/A_o	$1.20\ P/A_o$	$0.20\ P/A$	0.200	0.182	0.018
30	P/A_o	$1.30\ P/A_o$	$0.30\ P/A$	0.300	0.262	0.038
40	P/A_o	$1.40\ P/A_o$	$0.30\ P/A$	0.400	0.336	0.064

by T. C. DU MOND,
Editor, Materials & Methods

New Casting Process Combines Features of Other Forming Methods



Heat and pressure are combined to produce castings by the Bacco process. During the cycle, high pressure is exerted uniformly throughout the heated die. Higher physical properties result.

Increased strength properties, improved finish, and less need for machining are some of the advantages gained in the production of ferrous and nonferrous parts by this newly developed process.

● CASTING, MOLDING, forging and coining are, in effect, achieved in one operation by the newly developed Bacco process. The process, after several years of development and experimental work, is now to be more widely used by licensees of Budds Aero Casting Co., Canaan, Conn. The process can be used with most castable materials as well as some that are not so considered, including aluminum, steel, brass, bronze and copper.

Although other claims are made for the process, those of most general interest are: (1) machining can be reduced by about 60% on parts made by this method as opposed to casting; (2) materials formed by the method are given tensile and ultimate strengths about 10% higher than the same materials formed by other casting methods; (3) on most dimensions tolerances of 0.002 in. can be held. These characteristics of the process result in subsidiary advantages, not the least of which is a considerable savings in materials through the process itself as well as by making possible reductions in section thicknesses by virtue of higher strength.

Largely responsible for the increased physical properties is the dense structure attained in the metal. In addition voids, discontinuities, and porosity are reduced to a minimum.

The Bacco process is not claimed to be or considered a cure-all for casting problems, nor an all-out competitor of existing forming methods. Its chief field of application lies among parts where considerable machining is required as now produced.

In action as well as effect, this new forming method combines features of

several other methods. For example, the metal is melted in a gas-fired furnace, then poured by ladle into a metal die. The die is heated to a temperature near that of the metal being poured. Constant pressure is exerted on the die while the metal sets, but early in the cycle, extra pressure is placed on the die to obtain a forging action.

Because of the use of pressure during the period when the metal is setting-up in the die, gases are forced out of the metal, largely eliminating the shrinkage problem. Without the need for making allowances for shrinkage, the dies can be made to final dimensions with rather close tolerances being attained on the finished part. In most cases impurities in the metal being formed are forced out of the die when the high pressure is applied.

Surfaces of parts produced by the Bacco process are extremely smooth as they come from the dies. Aluminum parts so produced appear upon examination to be almost as smooth as if buffed. The process developers state that parts have been plated with satisfactory results without any preparation other than cleaning. Steel parts made by the Bacco method are said to take on surfaces superior to those attained on nonferrous parts.

Materials Used

Since many of the parts produced in the Bacco development shops have been for armament and military aircraft programs, aluminum has been worked with extensively. Production parts tested and accepted for military use have all shown physical properties well above the specifications for the particular alloy used. In certain cases, wrought alloys have been melted and cast with the same result, namely an increase in physical properties.

Aluminum alloys most frequently used are 356, an alloy recommended principally for sand and permanent mold castings; 195, a sand casting alloy; 14ST, a wrought alloy; and 4110, a special casting alloy.

The 356 alloy has a specified typical tensile strength of 33,000 psi., and elongation of 3%. Test results on pieces formed by the Bacco process show tensile values ranging from 33,000 psi. to 41,150 psi. and elongation values of from 4.7% up as high as 9.4%. Similar results are shown with 4110 alloy. In this case typical tensile strength is specified as 33,000 psi. and elongation between 3 and 3.5%. Bacco process parts tested from 33,310 to 44,446 psi. and elongation ranged from 6.3% to 10%.

In aluminum alloy 195, tensile strength was increased from 28,500 psi. up to as high as 36,650, with elongation holding at the specified 3% or dropping slightly to 2.5%.

Alloy 14ST, taken in its wrought form, was melted down and cast, a supposed impossibility. The wrought material showed 65,000 psi. tensile strength, 10% elongation and 125 Brinell hardness. Cast by the Bacco process, the tensile strength was increased to 66,450 psi., hardness to 130 Brinell, but elongation decreased from 10% to 8%.

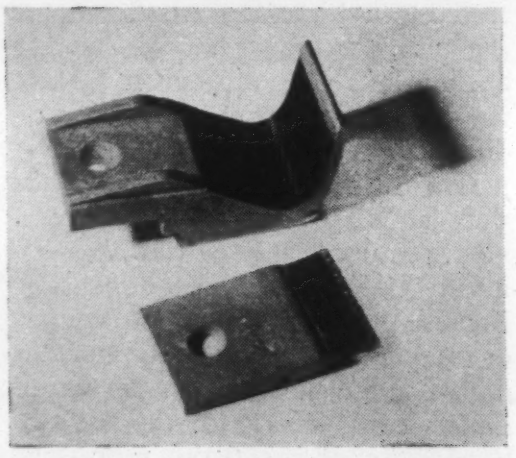
Several different bronzes and brasses have been cast with increased properties similar to those achieved in aluminum. In one alloy an increase of 14% in elongation was achieved. In another the tensile strength was raised from 18,995 psi. to 28,165 psi.

Although steels have been cast less than other materials, developers of the Bacco process are confident of its value in forming steel. Thus far 1081 and 1043 steels have been cast, with an average increase in properties of about 10%. The finish of steel parts is said to be even better than that attained with aluminum. The smoothness is limited only by the finish of the die in which it is formed.

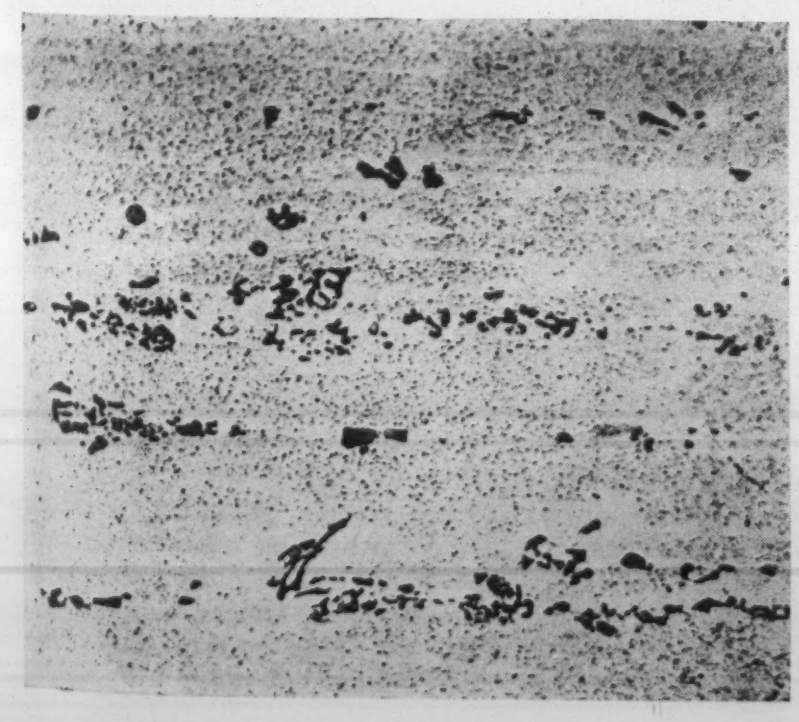
Where the Process Fits

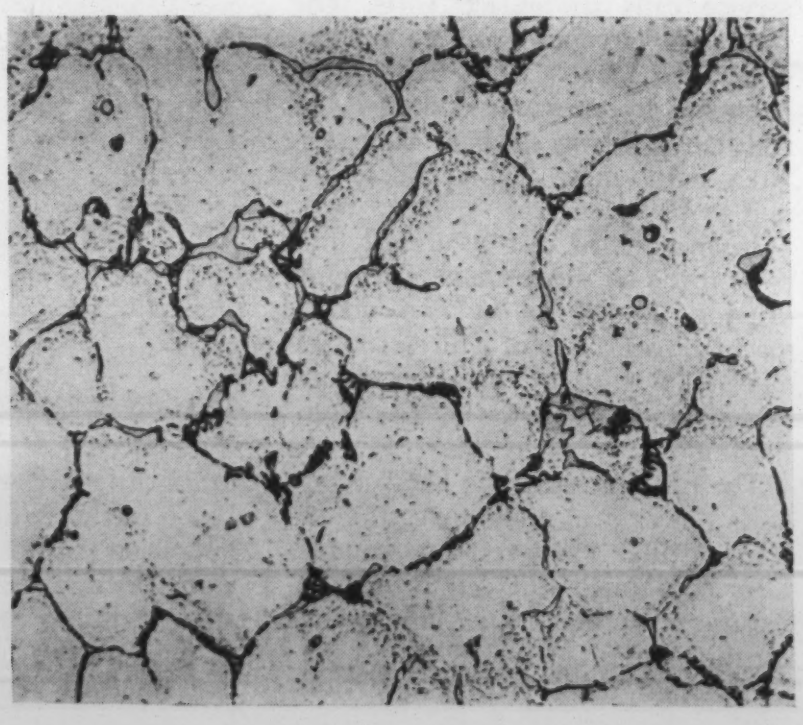
At this writing, it is too soon to determine exactly where the Bacco process will best serve. However, some of the parts already produced and in service give a good indication of suitable applications. As stated

More than 30 steel inserts are cast into these aluminum parts, intended for textile machinery.



Shown here is the apparent difference in aluminum meeting the specifications of 14ST. The photo at left shows the material in its wrought form, while the other shows the same alloy in cast form. The cast material is relatively free of intermetallic compounds. (Magnification 500X, 1% hydrofluoric etch)





previously, the Bacco process does not compete in making simple forms produced by other methods. It is expected to serve best where parts require lightness and high strength, where considerable machining would be required on parts made by other methods, or where it is important to save materials.

A few examples of parts which have been produced will serve to show the type of application that seems ideal.

One part which has proved itself is the lens mount of a special motion picture camera. As produced by other methods, approximately 23 machining operations were required to provide all of the necessary bosses and openings. Through the Bacco method a part is turned out that requires only three simple machining steps. The total weight is also reduced and, at the same time, strength has been increased.

In the case of a cast iron car door gear with teeth on the outer periphery and on one face, even greater savings have been effected. Previously, the cast iron blank required that all teeth be cut. Now, all gear teeth on both surfaces are cast in and the only machining required is the cutting of a groove between the two rows of teeth. Again, weight was reduced appreciably.

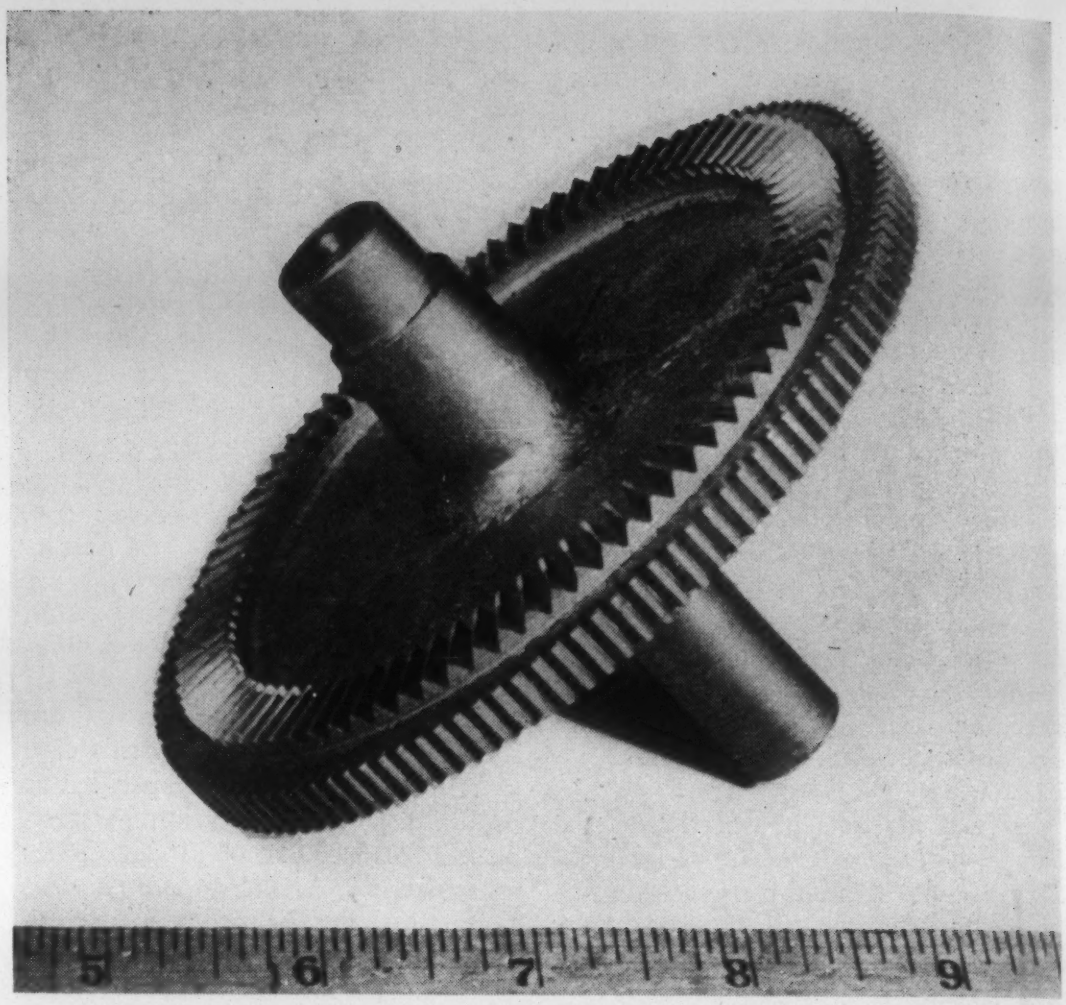
One of the smallest parts made thus far is a tripping finger of business machines. The part is approximately ⅜ in. in its largest dimension. Because of holes through two centers of the part and a groove for tightening when attached, stresses developed in service which caused the parts to break. Use of the Bacco process to produce the parts increased their purchased cost, but this was more than offset by enormous reductions in service calls to replace parts. The parts are produced in a multiple cavity die, 18 at a time. More could be made at one time if desired. In addition to being stronger than previous parts, those cast by Bacco are said to be stress-free.

Inserts can be cast accurately into parts made by this process. This type of work is typified by two textile machine parts, each of which requires more than 30 rigidly held and evenly spaced steel parts to be cast into aluminum.

The time cycle for the Bacco process is slower than mold die casting or sand casting. However, on suitable parts economies still can be shown because of savings in machining and finishing time.

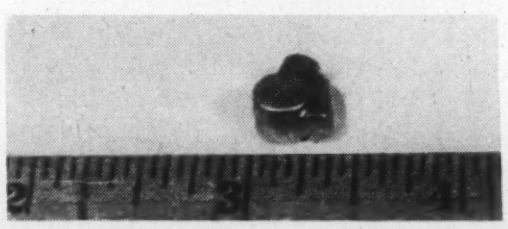
Although there will be practical limits to the size of parts made by Bacco methods, theoretically the only limitation is the size of the press used. Since rather high pressures are applied during the solidification part of the forming cycle, the press must be sufficiently large to provide the pressures.

Parts already produced by Bacco methods are being used for aircraft, typewriters and recording machines, hydraulic jacks, athletic supplies, superchargers and pressurizing units, among others.

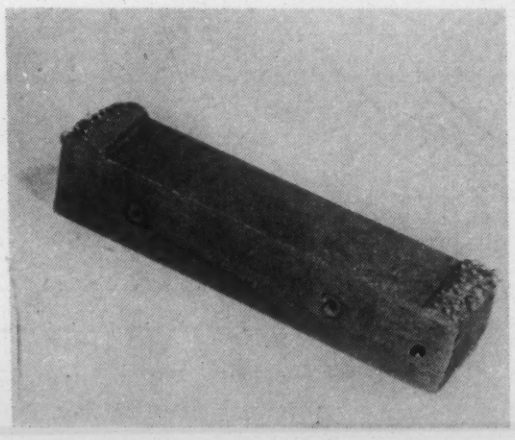


All of the teeth are cast into this aluminum gear, the only machining necessary being the cutting of the groove between the rows of teeth.

This part, for office equipment, is about ⅜ in. long on its greatest dimension.



Evenness of pressure during solidification of the metal is demonstrated by this section of a piece into which there has been cast an electrical element.



The finish on this aluminum part is exactly as it comes from the die when produced by the Bacco process.

Vitreous Enameling Broadens Scope of Aluminum Applications

New low temperature porcelain coating for aluminum alloys has excellent service properties and is available in many colors.

by **N. BRUCE BAGGER**, Associate Editor, Materials & Methods

Quick freeze units are typical of the many potential uses for vitreous enameled aluminum in the appliance field.

• THE DEVELOPMENT OF a satisfactory vitreous enamel for aluminum and its alloys has been long-awaited for many varied applications, no such finish having been available up to now for this versatile engineering metal. The Electrochemical Department of E. I. du Pont de Nemours, however, has recently produced a frit-based enamel that is fired on aluminum strips, sheetings and castings in furnaces much the same as those used for the vitreous coating of steel but at considerably lower temperatures. Unlike the steel coatings, the new aluminum finishes have the advantage of superior impact and flex resistance, excellent resistance to thermal shock, and will not develop unsightly rust if accidentally chipped or cracked. The enameled aluminum can be cut and, to a limited extent, bent or formed after firing and is unusually resistant to the action of mild acids. A very wide range of colors can be achieved by altering the formulation of the vitreous coatings.

The frits used in these coatings are highly alkaline and contain a high percentage of lead. Because of this fact, the new enamels are unsuitable for articles that are likely to come into contact with food. Widespread use of the enameled aluminum, however, is expected in such applications as storefront panels, advertising displays, sanitary ware and accessories, washing machine tubs and agitators, architectural tile, outdoor furniture, and the like.

At the present stage of development, only 2S, 3S, 52S and 61S wrought alloys and non-porous castings of 43 alloy are recommended for vitreous enameling. It is expected that additional research will lead to the satisfactory application of the enamels to other aluminum alloys.

Cleaning and Pretreatments

In general, any surface that can be easily reached with a spray gun can be enameled. Thin non-rigid sections must usually be enameled on both sides to prevent warpage, and sharp corners or edges should be avoided to prevent excessive drip, tearing, or sag in the finished coat. Appearance of the properly finished article will depend principally on good metal stock. In the case of castings, it is absolutely essential that they be substantially free of porosity. Porosity in the metal, communicating with the surface, results in pinholes and minute spall marks in the enamel coating. Successful enameling also has been accomplished over welded seams joined with 1100 F Airco rod.

In all methods of fabrication, the metal stock should not be anodized or previously treated by strong corrosion-inhibitors or cleaners. Experience had shown that proper metal cleaning to assure a clean, active surface free of grease, oil and oxide is necessary to make the surface pretreatment and enameling that follows fully effective. Since the recommended pretreating bath is not a cleaner, the metal is first immersed in a water solution of ¼% "Duponal" and 6% sulfuric acid or equivalent. Solvent vapor degreasing can be used on bright sheet stock that is not heavily oxidized. After cleaning, the work is thoroughly rinsed and dried.

The pretreatment necessary for a good enamel bond is achieved by immersing the work in a hot water solution of 0.2% chromic acid, 19% potassium chromate, and 3.8% sodium hydroxide by weight. Immersion times and temperatures vary according to the alloy being treated. Both the bath and the pretreated stock should be handled with due regard to the caustic and chromate contents of the solution. Following immersion in the pretreating bath, the work should be promptly rinsed in clear water to stop chemical action, and then thoroughly washed.

Under-treatment may result in enamel spalling in use. Over-treatment causes excessive corrosion of metal, leaving a thick film of corrosion products which are not penetrated by the enamel. In moderate cases of over-treatment, stock can be enameled satisfactorily if this film of loose corrosion products is brushed off after prefiring. When over-treated or insufficiently-washed metal is enameled, the ground coat frequently spalls off on cooling or when the cover coat is sprayed. Such over-treatment prevents the ground coat from thoroughly wetting the base metal during firing.

Applying Enamel and Firing

Following pretreatment, the stock is prefired to a temperature of 970 to 1000 F for a minimum period of 5 min. for small charges of thin section. Upon cooling to room temperature, the prefired stock is sprayed with a thin coat of smooth, wet slip. In this operation, excess slip should be avoided, particularly in corners. The proper quantity of spray application can be judged by weighing the piece before spraying and after drying. From 15 to 20 gm. per sq. ft. are usually recommended for ground coat applications.

After spraying, the stock should be dried to prevent dust pick-up. Low temperature drying is desirable, since high temperature drying or excessive drying time may result in tearing. Usually, drying need be continued only to the point where surface moisture disappears.

Dried articles, well-supported on a suitable rack, are then fired under conditions the same as those for the prefiring operation. In production furnaces, firing conditions will depend on load in furnace, thickness of metal sections, locations of pyrometers, and other factors. Care must be exercised to avoid too high a temperature to prevent excessive metal deformation. Too low a temperature or too short firing time, or both, will result in an inadequately bonded ground coat. This defect shows up by spalling on cooling or spalling during application of cover-coat slip. It should also be noted that such failure can result from over-treatment of the metal prior to enameling. Refiring at higher temperatures or for a longer period generally corrects underfiring. As the purpose of the ground coat is merely to bond cover coats to stock, a thin application is adequate.

After cooling ground-coated stock to room temperature, the cover coat is applied by spraying. It is essential that the ground-coated surface be kept free of grease, oil or dirt on articles to be enameled in bright colors, as organic material will burn under firing and leave dark carbon marks. One such coat will usually suffice and can be applied to the necessary thickness, again avoiding excess in so far as possible in corners. The total deposit of ground and color coats should be from 40 to 70 gm. of enamel solids per sq. ft. Should difficulty be encountered with tearing, it can usually be overcome by applying two lighter cover coats, each separately fired.

The cover coat is fired under conditions similar to those for the standard ground coat, *i.e.* about 970 F. Over-firing may result in failure in the accelerated spalling test, and for this reason should be avoided where at all possible. It should also be noted that the thickness of the cover coat and the firing conditions can affect in some degree the ultimate color obtained.

To achieve multiple-color cover coat effects, a cover coat of one color is first sprayed and fired on the standard ground coat. Upon this cover coat, other colors can be sprayed and fired, masking or wipe-off techniques being used to obtain desired patterns or designs prior to the firing operation. Colored effects can also be achieved by the squeegee process, using specially prepared squeegee inks. In this, several colors, including the last overall cover coat, can be fired simultaneously.

It is not expedient to apply multiple color coats by brushing dried enamel from a sprayed coat through a stencil because, on drying, these enamels bond very firmly. As a further deterrent to this practice, lead dust hazards are also incurred which exert a decided influence on the factor of employee safety.

Commercial development of vitreous enamel for aluminum was long retarded by the spalling that occurred when test pieces were exposed to atmospheric conditions. The improved method of pretreatment discussed above appears to have corrected this earlier deficiency when judged by an accelerated spalling test. This test consists of immersing finished samples in a 5% ammonium chloride solution at room temperature. At least 6 in. of interface between enamel and metal is exposed on each piece. The specimens are examined after 24 and 96 hr., failure being judged by the loss of enamel progressing over ⅛ in. in from the edge over a ½-in. breadth. The exact amount is not critical because failure generally is very extensive or else negligible. Evidence to date shows this method of testing to be the best and quickest measure of the ability of the enamel to adhere under weathering conditions. However, time will be required to show the extent to which this test can be relied upon to indicate satisfactory life of enameled articles under conditions of actual use.

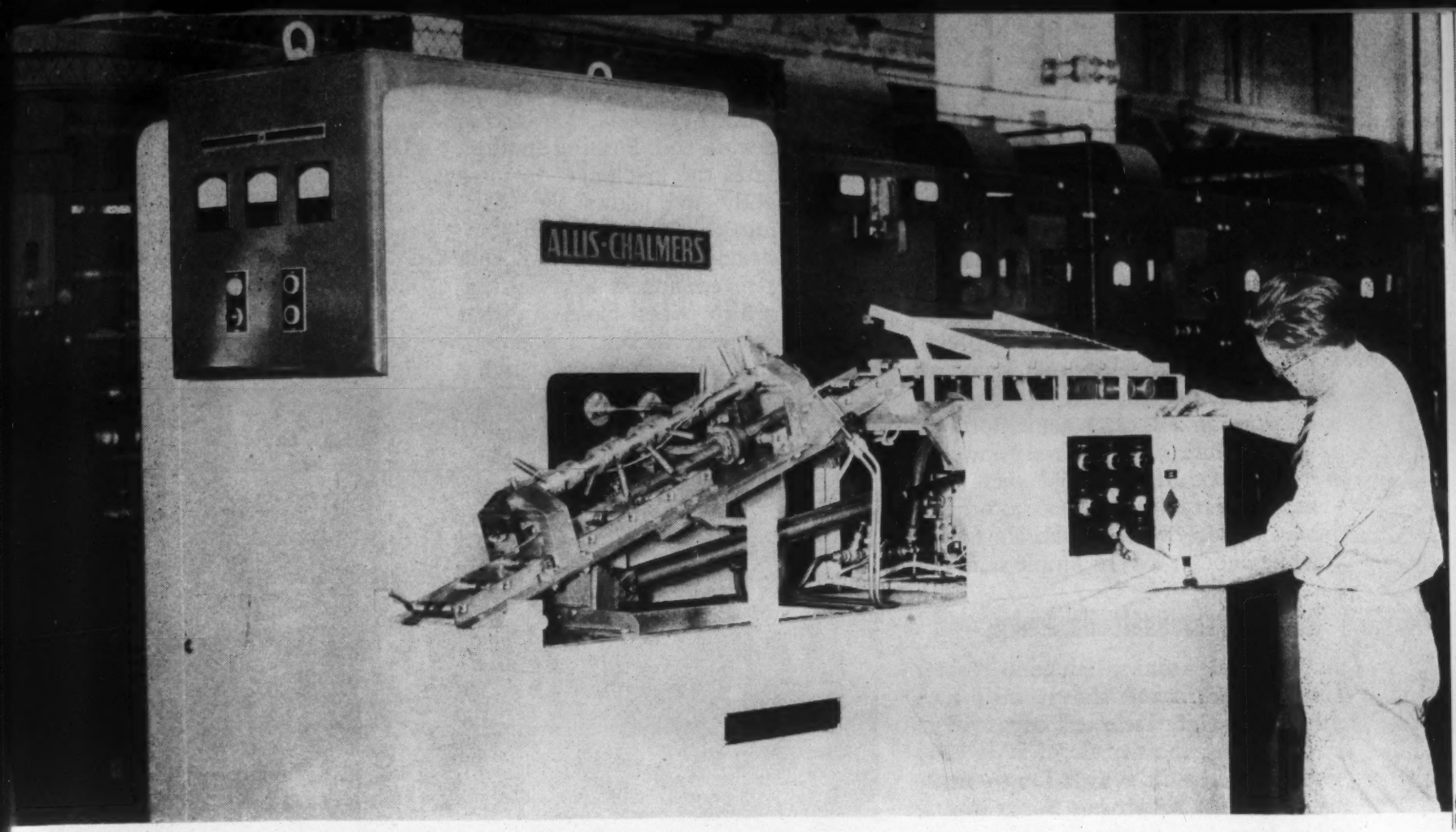


Fig. 1—This electronic induction hardening machine to harden rocker arm shafts uses a fully automatic work fixture and hardens eight areas on each shaft at the rate of one shaft per min.

Production Economies Realized by Proper Use of Induction Heating

by J. A. EVANS, Allis-Chalmers Manufacturing Co.

The case histories given here demonstrate the versatility of induction heating and how its carefully planned use results in better and lower cost heat treating and brazing.

• WHEN A NEW PRODUCT is to be developed it is just as essential to consider materials and production methods as product design, and the three should be worked out together as a unit. With new materials and methods of production being developed, it is possible in many cases to effect design changes to lower production costs. It is in keeping with this trend that the induction heater with its versatile method of processing metal parts has been so great a help to industry.

Induction heating can be applied to ferrous (magnetic) and nonferrous (nonmagnetic) metals. In the former, heat is induced into the work by means of both eddy currents and hysteresis losses, while in the latter only eddy current losses are produced. This makes it somewhat more difficult to load into nonferrous metals.

With induction heating, especially case hardening applications, there is generally a greater freedom in the choice of suitable metals for a particular job. This among a number of other reasons has brought out the usefulness of induction heating. The only critical factor of a metal with induction hardening is the carbon content. Plain carbon steels such as SAE 1045 give excellent results for a large variety of applications. However, where the specification requirements are more rigid or for other reasons, it is often desirable to use a more complex alloy.

For example, valve lifter rods must have hardened ends to withstand constant pounding. These rods can be made of plain low carbon steel whose ends have been carburized, heated in a furnace, and then water quenched to give desired hardness.

In order to avoid the excessive scale caused by furnace hardening, the rod ends can be selectively induction hardened; the carburizing process can also be eliminated by using a SAE 1045 steel. This type of steel, however, frequently requires drawing back the hardened area in hot oil to prevent overstressing or cracking of the metal. To eliminate the drawing operation, a higher alloy steel such as SAE 1165 can be used with an oil quench. The portion to be hardened is quenched slower in oil, but the higher alloy reacts better and faster.

As with any other process or method, induction heating must be

justified by resulting in lower costs, superior quality of product, improved working conditions, or a number of other reasons. Thus, a thorough investigation of the economics and performance must be made before any investment is made. The production set-ups described below are applications where an electronic induction heater has proved itself in actual production. In all cases some form of work fixture was required; however, it must be remembered that these fixtures vary from job to job. Some may require a very elaborate fixture while another a very simple one.

Rocker Arm Shaft Hardening

The electronic induction heater and work fixture shown in Fig. 1 hardens eight selected areas of a rocker arm shaft made of SAE 1045 steel for use in a well-known make automobile. At present this company has four Allis-Chalmers 20-kw. units which, in conjunction with proper work fixtures, are cutting costs and improving product quality. This particular fixture is one of the more elaborate ones and is fully automatic. The control of the complete unit is by means of pushbuttons on the control panel.

This rocker arm shaft is about 17¼ in. long, has an ID of about 17/32 in. and an OD of about 13/16 in. The particular areas to be hardened are about 1¾ in. long, contain an oil hole and slot, and are hardened to Rockwell 55C or better with a case depth of 0.020 in. The heating time is 2 sec. with a 3.5-sec. quench. The hardening operation produces no objectional scale or warpage.

Shafts to be hardened are placed on the inclined rack just above the control panel and the completed shafts slide off the incline to the left into a work bin. When only three or four shafts remain to be hardened on the inclined rack, a signal is given to indicate that more shafts should be placed on the incline. No handling of the work is required during the hardening process.

In operation, the induction heater is first turned on and the fixture brought to the correct sequence of operation by means of pushbuttons. Pushing another button causes an air cylinder to reach back and pull a shaft from the bottom of the inclined rack so that it slides onto the second incline. Because the shaft with the adjustable fingers located on the work fixture has been properly set, the rocker arm shaft stops when it strikes the first finger before entering the work coil. Pushing another button causes the first finger to turn away slightly and allows the shaft to slide into the work coil and stop at the second finger. This and the following seven fingers have spring contacts which, when closed by the pressure of the rocker arm shaft, cause a multiflex timer to operate. The fingers are located so as to stop the shaft at the proper place in the work coil in order to harden each of the eight required areas.

When the contact on each of the fingers is closed, the sequence of the timer is to turn on the RF power, turn off the RF power after the heating cycle, water quench the piece

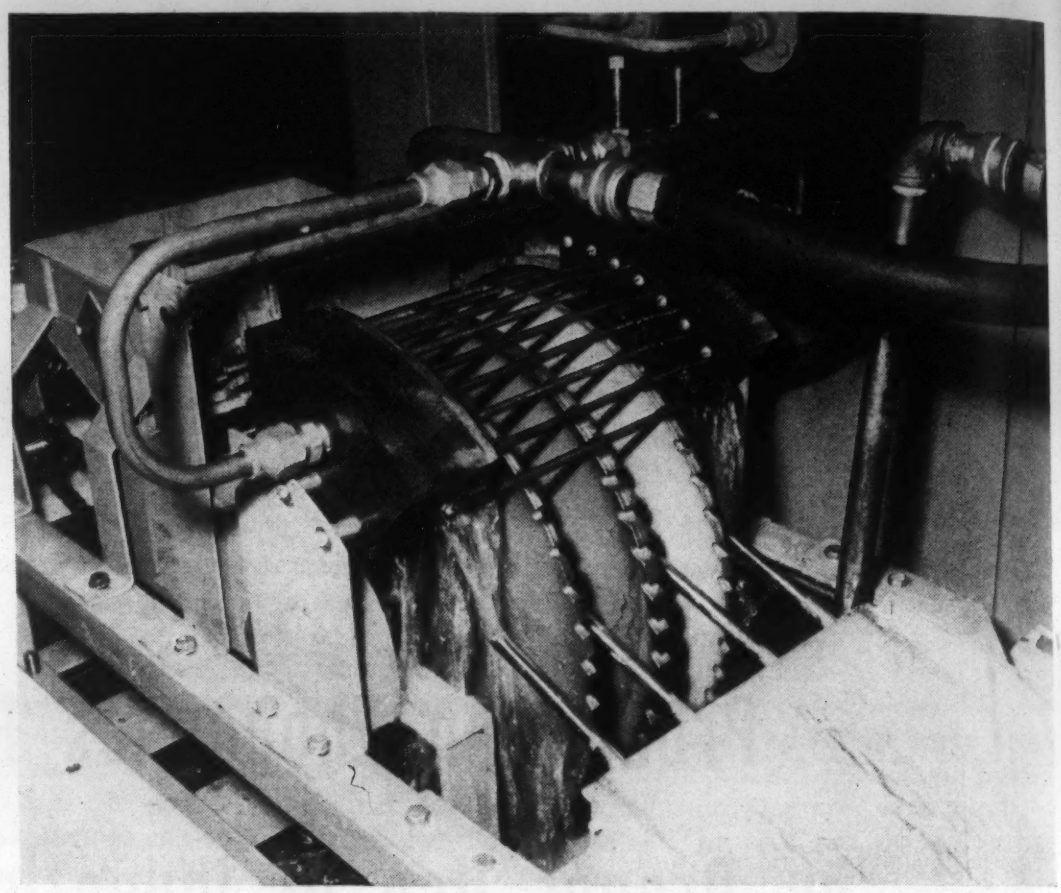
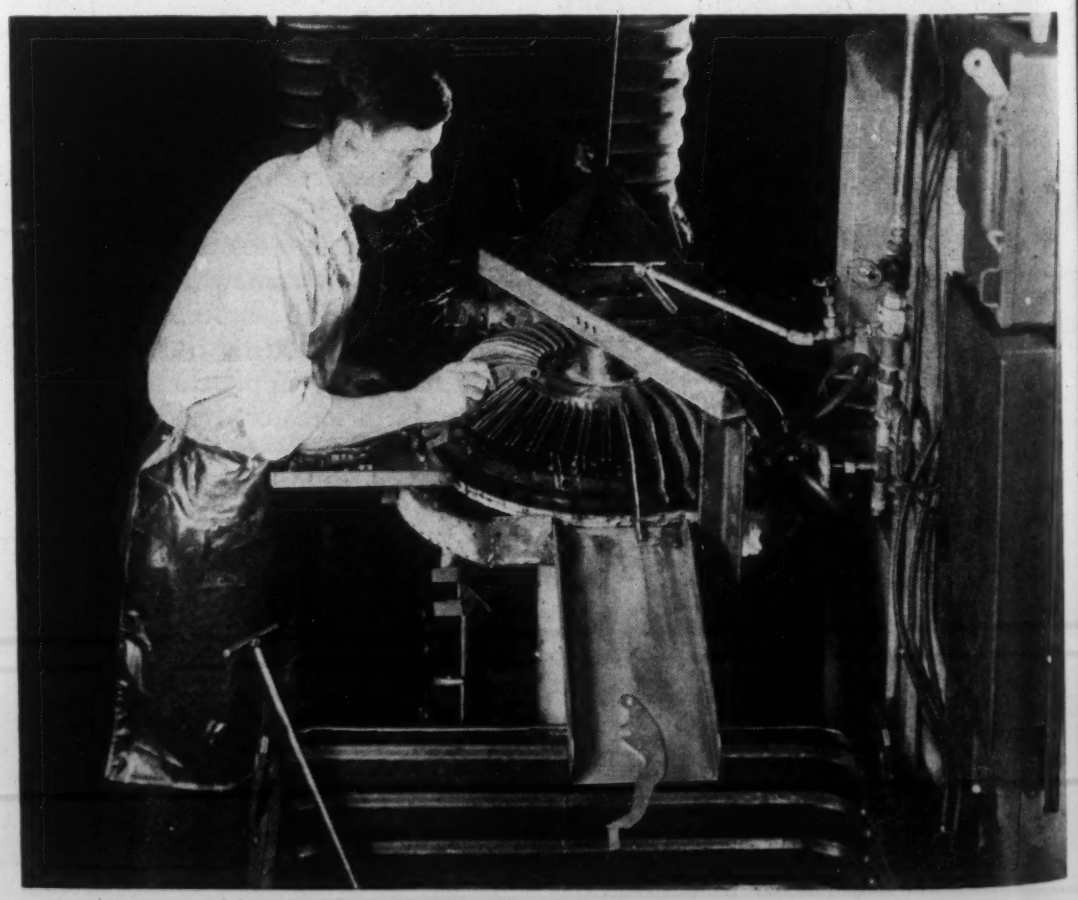


Fig. 2—Valve lifter rods are through hardened on both ends by means of this automatic fixture at a rate of 3600 per hr. The hardened area is about ⅝ in. from each end and has a hardness of 55 Rockwell C or better.

Fig. 3—A semi-automatic fixture induction anneals automobile brake arms at the rate of 2400 per. hr. The section annealed is that shown beneath the right hand of the operator as he loads the fixture.



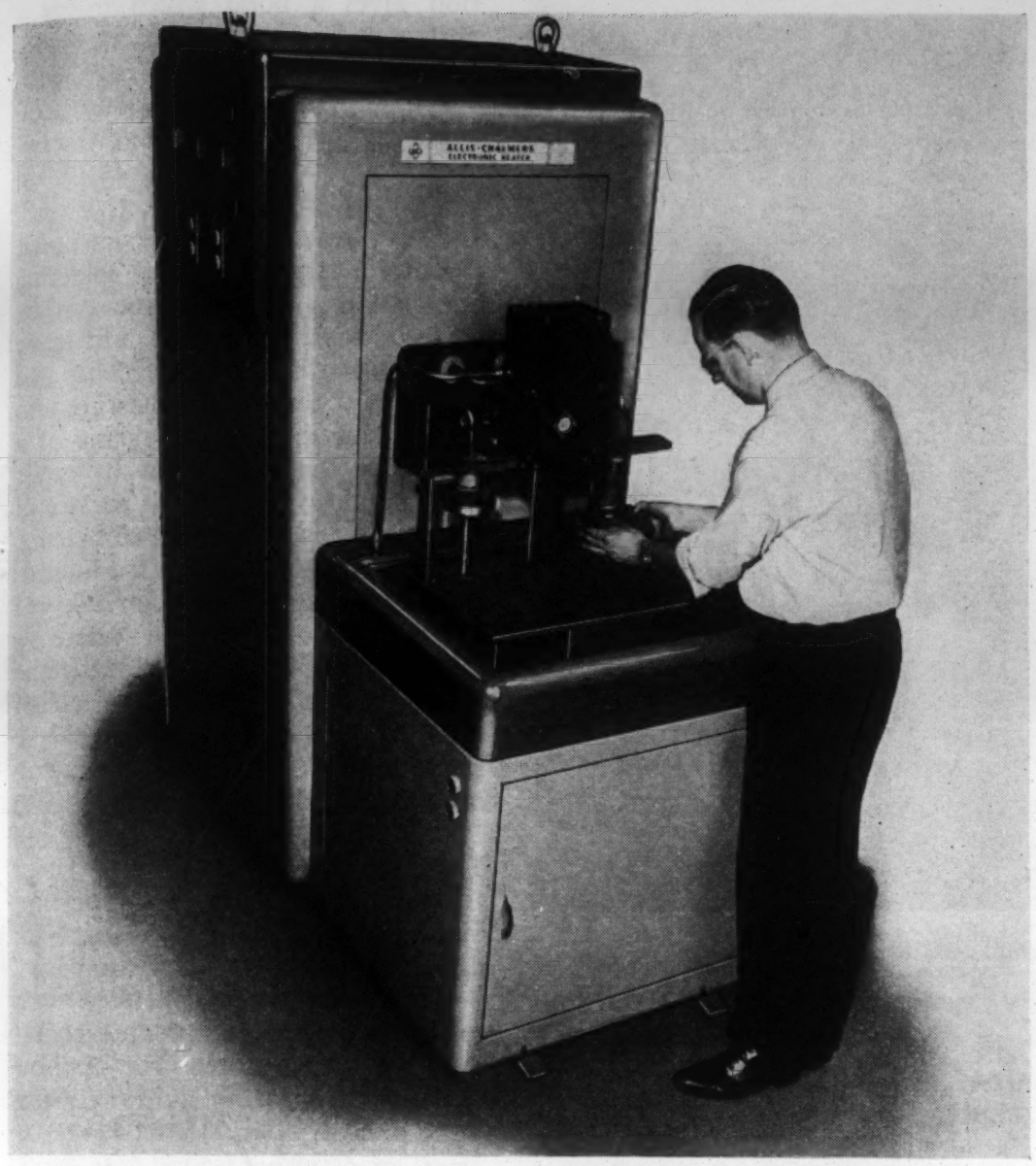
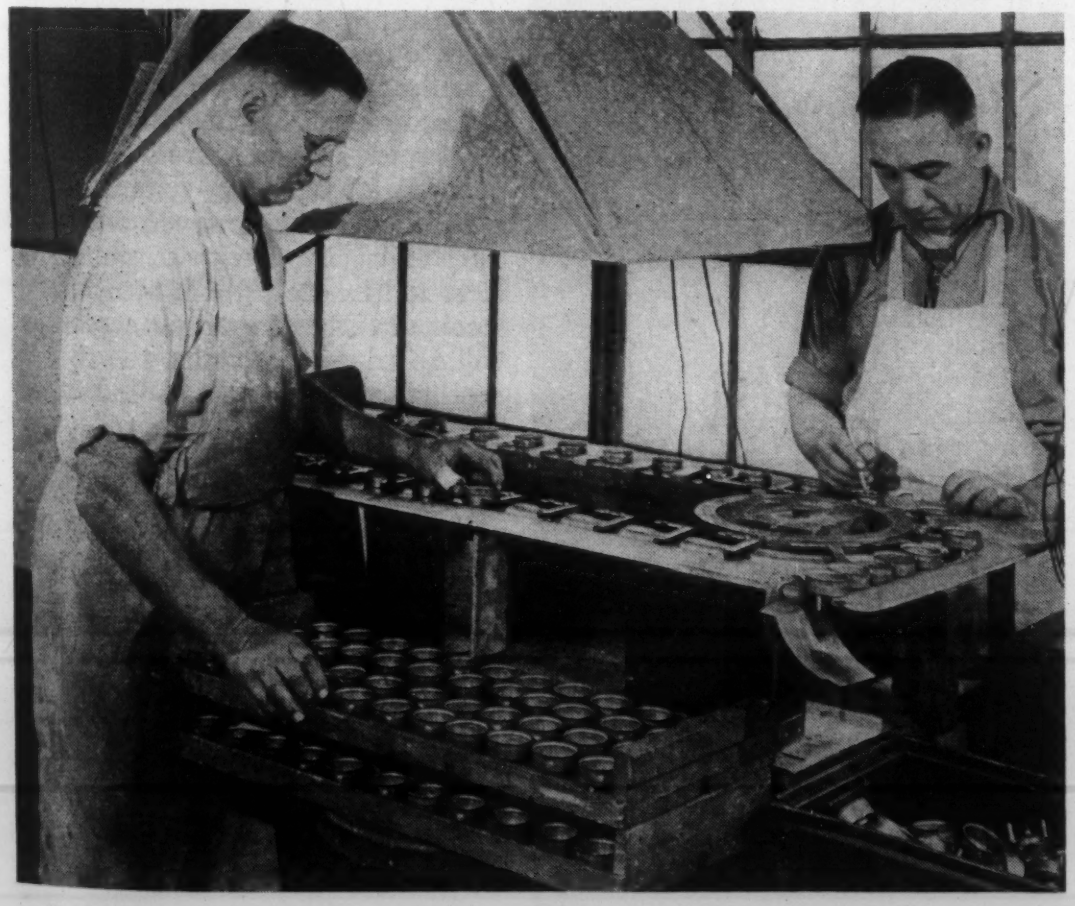


Fig. 4—An electronic induction heater anneals the splined bore of transmission gears prior to the broaching operation. The RF switch increases production by performing the annealing operation on one side of the switch while the other side is being unloaded and reloaded.

Fig. 5—A soldering application of oil gages on a production line basis. Induction soldering and brazing has greatly improved both quality and quantity of many applications.



immediately after RF power is off, turn quench water off after the quenching cycle. The finger then turns slightly to allow the shaft to slide down the incline so as to strike the contact of the next finger. After all eight areas have been hardened, and the last finger has turned away allowing the shaft to slide off the incline, the air cylinder reaches back for another shaft. This next shaft slides into the work coil stopping at the second finger and repeats the eight hardening operations automatically. The production rate is about 60 shafts per hr.

Synchronized Hardening Process

Fig. 2 shows a fully automatic unit for through hardening the two ends of valve lifter rods. These rods are hardened at the rate of about 3,600 an hr., and require no handling other than placing the rods in a bin and removing the hardened rods from another bin. The rods are about 9¼ in. long, about ¼ in. in dia. The ends are through hardened from ½ to ¾ in. from each end. The hardness of the cold drawn SAE 1045 steel averages better than 55 Rockwell C for this application.

The valve lifter rods are first placed in a bin on one end of the fixture which has an opening on the side at the bottom so that the rods can be picked up by the notches on the drum as it turns. The rods are picked up one at a time as shown and are carried through the work coil so as to through heat the ends. They are then passed progressively through the quench block. As the drum continues to turn, the rods drop off the drum and fall into another bin. The quench media is water and the rods are drawn back in hot oil within ½ hr. after they are quenched. A variable speed drive can adjust the speed of operation of the drum. An alloy such as SAE 1165 can be used with an oil quench, which eliminates the necessity for drawing back the rods.

Hardening Brake Arms

Fig. 3 shows a semi-automatic work fixture for annealing automotive brake arms made from a low plain carbon steel. The section to be annealed is shown just beneath the right hand of the operator as he inserts a piece into the rotating fixture. As the table rotates the bottom portion of the piece is carried through the work coil. This work coil connected to the electronic induction heater brings the desired portion up

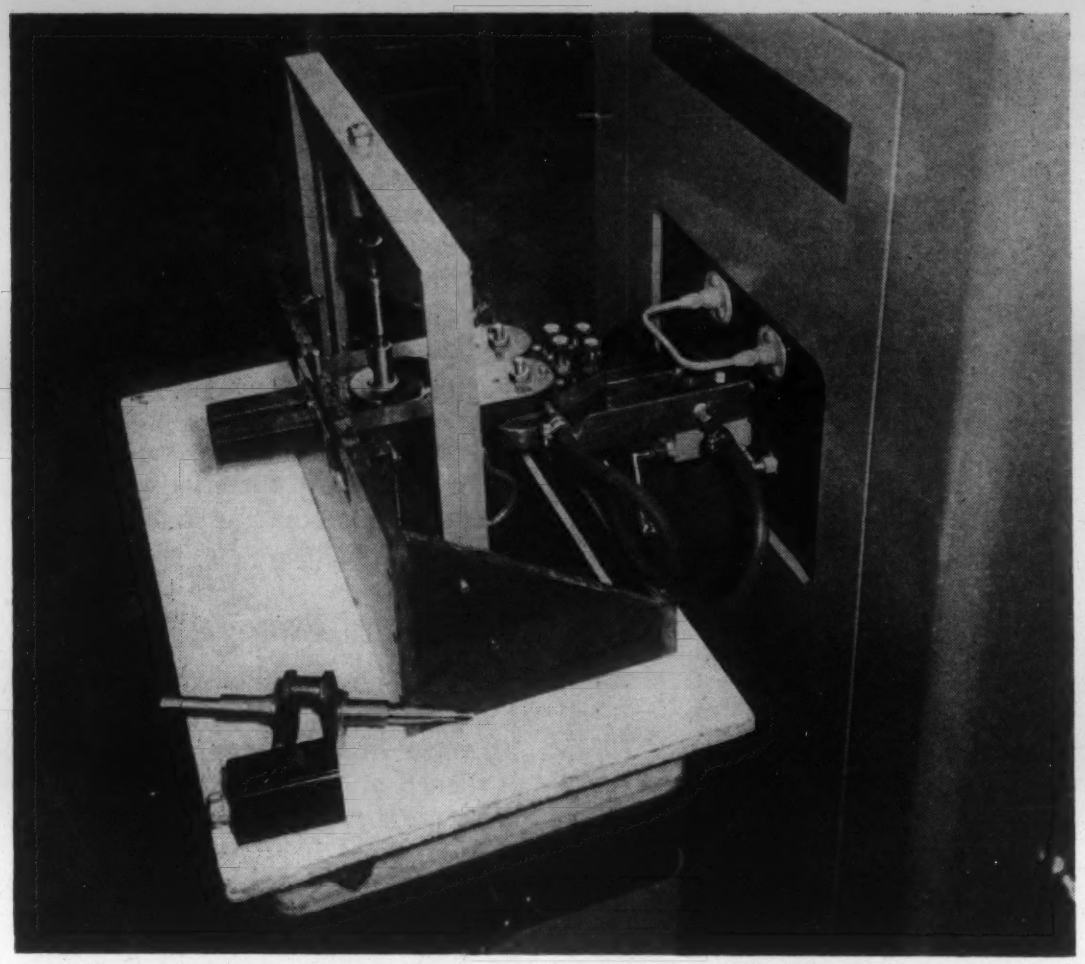


Fig. 6—A clamp-type coil to case harden crankshaft and camshaft bearing surfaces.

to annealing temperature. As the piece reaches the slide which is directed into the tote bin, the piece is released and slides into the bin as shown.

The 20-kw. heater anneals about 2,400 pieces per hr., and all the operator has to do is load the pieces into the fixture. Only the desired portion is heated, and there is no objectionable heat to bother the operator.

Annealing Internal Splines

A semi-automatic work fixture to anneal the internal spline of transmission gears prior to a final broaching operation is shown in Fig. 4. This fixture makes use of what is called an RF switch, which can be used on a number of similar adaptations. The sequence of operation is such that while one gear is going through its annealing operation, the operator can prepare a second gear for its heat cycle.

After the induction heater is turned on and ready to heat, the operator positions the first gear on one of the supports. The foot pedal operating this support is pressed and the support is raised up to the coil by means of an air cylinder. As the work coil enters the gear a micro switch turns on the RF power when the gear comes to the end of its travel. While this first gear is being annealed a second gear is placed on the second support. When the preset timer times out, the RF power is turned off and the gear support is lowered. By this time the operator has positioned the second gear and is ready for a repeat operation.

The internal annealing has no effect on the hardness of the external gear teeth. The fixture is built so as to rotate the gear during the time it is in the raised position, resulting in a more uniform heat pattern. A considerable saving was realized from this induction annealing operation. It is also possible through the use of an RF switch to perform two separate operations, one after the other, without changing any work coils. That is, two different size gears can be annealed, or one piece can be hardened on one coil and the second coil can perform a brazing operation, etc. This feature adds to the versatility of the electronic heater unit.

Soldering and Brazing Uses

Fig. 5 shows a work fixture with an electronic induction heater used in soft soldering oil gages. The oil gage is carried past the work coil by means of the conveyor system, and a brass diaphragm is soldered onto the inside at the bottom of a sheet metal stamping. The soldering operation gives a bond which makes a perfect seal without any excess solder material flowing onto the diaphragm. The production rate is about 1,800 gages per hr. A hood above the fixture carries away any fumes caused by heating the flux.

It can readily be understood that there is a large variety of soldering applications, and the same can be said for brazing. Not all, but many of them can be done effectively and efficiently by induction heating. An example of this is the brazing of a plug into the end of an hydraulic jack cylinder. The internal surface of the cylinder is honed, before brazing, up to the edge of the bonded joint of the plug. The specification allowed discoloration of the honed surface ½ in. from the plug; with electronic induction heating no discoloration extended beyond 1/16 in. from the plug in spite of the fact that brazing material could be seen from 90 to 100% around both sides of the joint. The results were especially good considering the fact that the brazing material flowed about 5/16 in. from the center to each side of the plug.

Fig. 6 shows a hand operated work coil and fixture for hardening crankshaft bearing surfaces. The application shown is a single throw crankshaft whose pin is 1⅛ in. long and ⅞ in. in dia. The desired case depth is between 0.035 and 0.050 in., with a 50 to 55 Rockwell C hardness when a SAE 1340 steel is used. The heating time with a 20-kw. electronic induction heater is 15 sec. per crank pin with an extra 10 sec. for quenching.

This split type inductor with automatic quench was designed and built by Allis-Chalmers Manufacturing Co. to improve the method of hardening crank pins and cam shafts by means of induction heat. The fixture shown is hand operated; however, other fixtures are available with clamping devices and interlocks both manual and automatic. The size of the crank pin will, of course, determine the size of the inductor, duration of heat cycle, and output capacity of the induction heater.

The advantages of this method are rapid heating, minimum distortion, no objectionable scale, better working conditions, less handling, and an improved product. The type of steel used can vary from plain carbon steels to the more expensive alloys, depending upon the required specifications. The quenching media must also conform to the requirements, but water is generally used for this purpose.

How to Select Materials for Plastic Mold Cavities

by L. J. MORRISON, Detroit Mold Engineering Co.

A wide variety of mold materials is now available, and choosing the most economical one for a given application requires careful evaluation of the many factors involved.

• SO MANY DIFFERENT materials are used for plastic mold cavities that the uninitiated engineer is likely to be confused. For there is little specific agreement among molders, mold makers and steel manufacturers as to the proper selection of cavity materials. Each molder or mold maker has his own preference; he knows how it machines and polishes, and how it responds to heat treatment. To deviate from this preference is to risk considerable loss and questionable gain. Apparently the steel manufacturers have little to suggest in the way of steels designed specifically for molds. Surveys made by our company indicate that, as a whole, the steel makers are not too well informed on the problems of molders and die makers. It is natural, then, that the consumer should rely largely on his own experience and judgment.

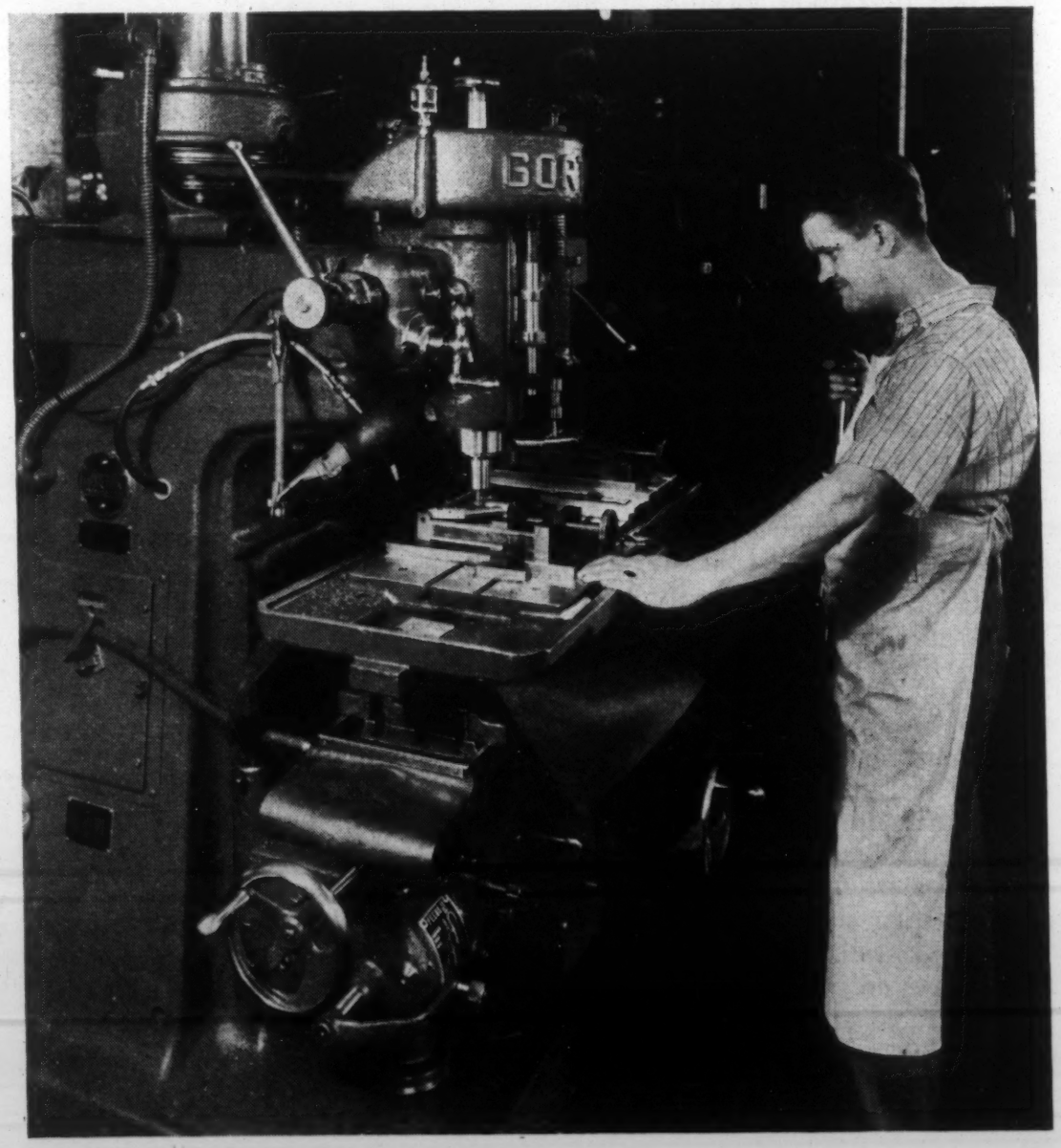
It is the purpose of this article to discuss briefly the advantages and limitations of the various types of materials (mostly steels) used for plastic mold cavities, and to indicate the factors to be considered in selecting the proper material for a specified set of molding conditions. In order to give a more complete picture of the materials problem in plastic mold design, a short outline of the materials used for other parts of the mold has been included.

First we should establish some criteria by which to judge materials for mold cavities. From the standpoint of mold manufacturers, steel used for mold cavities should machine freely, or hob easily under low tonnage, depending upon the forming method used. Both types should take a high polish and suffer minimum distortion when hardened. The steel must be clean — free from impurities such as sulfides, segregation or porosity.

From the molders' standpoint, the steel should have high surface hardness after hardening and high core strength. For some sections, high tensile strength may be essential. With these dual qualifications in mind, let us consider the various materials used for cavities.

Steels generally used for machined plastic molds include alloy carburizing oil-hardening, air-hardening and stainless types. Cavities made by the hobbing process present additional problems to the steel maker. In order to make steel as workable as possible for best hobbing conditions, the carbon content is lowered and all alloys are removed. The resulting cavity can be hardened only by carburizing, and then the core remains soft. Steels other than the plain low carbon variety can be and are hobbed, but

Steels used for mold cavities should machine freely and take a high polish. (Courtesy Fuller Brush Co.)



only at the expense of additional hobbing pressures.

Machine steel, otherwise known as SAE 1020, was one of the earliest cavity materials. It was universally obtainable, cheap and easy to machine, and so found widespread use. In addition to having low strength and hardenability, however, this steel is not as clean and does not polish as well as alloy types. Also, distortion in heat treating is a maximum in this steel. For these reasons SAE 1020 has been largely supplanted by alloy steels for mold cavities.

Alloy Carburizing Steels

The alloy carburizing steels represent 60 to 70% of the tonnage used in plastic molds. SAE 4615, 3120, 3312, 4130 and many other analyses fall in this category. All have the common fault of dimensional change as a result of carburizing, but this can be minimized by careful heat treating.

SAE 4615 is a molybdenum steel containing 1.65 to 2.00% nickel and 0.20 to 0.30% molybdenum. These alloys serve not only to toughen the steel but also to improve the carburizing properties, as they increase the rate of carbon pick-up at the surface. A core hardness of 280 Bhn. can be expected after heat treatment. In the annealed condition, machining and benching properties are excellent. The electric furnace variety is preferable.

SAE 3120 is a typical chromium-nickel mold steel. Addition of chromium improves hardenability and polishing properties. Core strength runs as high as 130,000 psi. It is somewhat more difficult to machine than SAE 4615.

SAE 3312 is a chromium-nickel steel, with nickel content raised to 3.5% and chromium to 1.5%. This steel can be hardened in air after carburizing and, therefore, distortion due to heat treatment can be minimized. Core strength of 160,000 psi. and hardness of 360 Bhn. are obtainable. Machining and benching are considerably more difficult than on the steels previously mentioned. All air-hardening steels have the further disadvantage of requiring careful annealing after welding in case of repair.

SAE 4130 (chromium-molybdenum) types are very popular as carburizing mold steels. This composition is 0.30 carbon (high compared to most carburizing mold steels), 0.65 chromium and 0.20% molybdenum. Although tensile strength and hardness are high, toughness and dimensional stability are not as good as in the SAE 3312 type.

Oil-Hardening Steels

Water hardening steels are seldom used for cavities. The drastic quench necessary in heat treatment makes the steel too susceptible to cracking, and distortion is a maximum. A great variety of oil-hardening steels are used, however. It is not practical to discuss here all the steels recommended, for nearly every molder and mold maker has his own idea of the best. Nevertheless, there are several types of oil-hardening steels which are widely used and are representative of the field.

Steels similar to SAE 1090, but with higher manganese content, have been used on small- and medium-sized cavities with varying success. However, alloy types have been used more generally because of better toughness and finish.

SAE 6150, a chromium-vanadium steel, is quite popular. Medium carbon content (0.50%) and 1% chromium combine to make an extremely tough steel. The vanadium (0.18%) produces fine grain. Oil quenched, the steel hardens to about 50 Rockwell C, considered low by many molders. Stability in heat treatment, machinability, and finishing properties are all good.

A general-purpose oil-hardening steel made by many companies has the following composition: 0.90 carbon, 1.25 manganese, 0.50 chromium, and 0.50% tungsten. Although its machinability is good, increased carbon makes this steel somewhat more difficult to machine than SAE 6150. The oil-quenched steel hardens to 60 Rockwell C and has good strength. Heat treatment of large uneven sections is generally not advised.

Air-Hardening Steels

The physical properties of some of the air-hardening steels make them probably best of all for cavity work. Known as "hot work" die steels, they are characterized by medium carbon content (0.35 to 0.45%), 4.0 to 5.0% chromium and varying smaller percentages of molybdenum, silicon, vanadium and tungsten. They have maximum core strength and toughness, and surface hardness up to 58 Rockwell C. The polish attainable is second only to that on stainless steel. Distortion in heat treatment is a minimum for there is no size change due to drastic quench or absorption of carbon as in carburizing. On the other side of the ledger, the hot work steels are among the toughest to machine and bench. Compared to the steels already mentioned, the cost per pound is also quite high.

For cavities for injection molds it is questionable if steel of this quality is necessary, but, for cavities and punches for compression molds, the best is often none too good. Long cores and cavity sections subject to high transverse stresses are best made of hot work steel.

High carbon-high chromium air-hardening steels are seldom seen in cavities but find use in hobs where their high compressive strength is advantageous. They do not have the toughness and resistance to transverse stress shown by the hot work steels.

Stainless Steels

When it is necessary to have the best polish possible, as in molds for lenses or fine jewelry, use of stainless steel is indicated. For this work, a type containing 0.30 carbon and 13.0% chromium is widely used. It is considered quite difficult to machine and polish. Free-machining grades are made by the addition of sulfur, but the high sulfur produces a "dirty" steel which will not polish to the perfection usually required of stainless steels.

Alloy Hobbing Steels

SAE 3110, containing 0.10 carbon, 0.50 manganese, 0.60 chromium and 1.25% nickel, is typical of the alloy hobbing steels. Its core strength is about two to three times that of plain carbon hobbing steel. Its machinability is just fair.

For master hobs, two types of steel are very popular: tungsten chisel and high carbon-high chromium. Tungsten chisel steel is probably the more widely used. It contains 0.50 carbon, 0.20 manganese, 0.75 silicon, 1.20 chromium, 2.50 tungsten and 0.25% vanadium. Pack hardening in charcoal followed by an oil quench produces a very hard skin (61 to 63 Rockwell C) and a tough core. This steel is especially resistant to transverse stresses due to irregularities of shape, one of the main causes of hob breakage.

High carbon — high chromium steels are used for hobs because of their extremely high compressive strength and their dimensional stability during heat treatment. Their resistance to transverse stresses is low.

Recent Developments in Cavity Steels

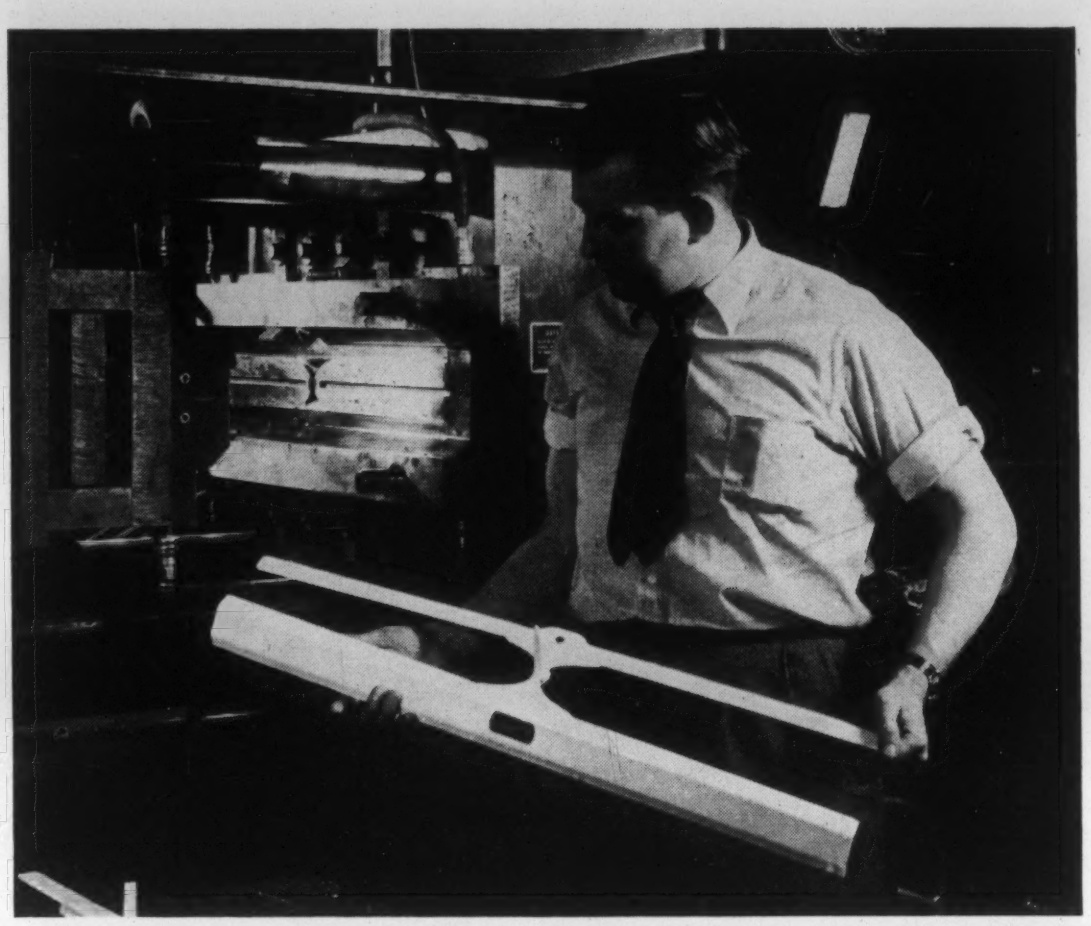
Recent developments in cavity steels have been confined principally to hobbing steels, the goals being improved machinability, increased core strength, and better dimensional stability during heat treatment. One company has been investigating an oil-hardening graphitic steel. Another has developed a 0.90% carbon steel that will give a deep case and hard core in carburizing. Tests have shown that both of these steels can be hobbed, but the pressure required is somewhat greater than that required by SAE 3110.

Most interesting advance is an air-hardening hobbing steel developed separately by Westinghouse Electric, Carpenter Steel, Crucible Steel and Bethlehem Steel. The analysis runs about 0.10 carbon, 0.37 manganese, 5.0 chromium, 1.0 molybdenum and 0.35% vanadium. This steel is more easily machined than ordinary hobbing steels but does not work harden as rapidly. It is hardened with low deformation by carburizing and air quenching; the resulting surface hardness is 57 Rockwell C and core hardness 25 Rockwell C. Preliminary results obtained from use of this steel indicate that it may be the closest yet to a universal mold steel for the plastics industry.

Other Cavity Materials

Materials other than steel are often used in cavities. Electro-formed cavities, made by plating iron on a rubber master, are occasionally used to reproduce extremely intricate work that is not too deep. However, the problem of backing up the plated cavities has not been satisfactorily solved and the long period of time—usually several weeks — necessary for the plating is objectionable. Plated cavities are of use principally for injection molds. Cavities made by spraying molten alloy steel on a revolving water-cooled master have been tried, but the process is still in the experimental stage.

Beryllium copper has great potentialities as a cavity material. It will reproduce the finish of the master it is cast upon, and it can be hardened to 40 Rockwell C. It is quite tough and does not tend to chip or crack. New alloys that will harden to 50 Rockwell C are being developed. However, much work has yet to be done on casting technique and materials handling. Beryllium copper is used mainly in cavities for injection molds, seldom for compression.



Selecting the proper steel for the large mold used in producing this part requires the weighing of many factors. (Courtesy Hydraulic Press Manufacturing Co.)

Selection of Cavity Materials

Selection of a particular type of material from the group enumerated now becomes largely a matter of economics. If the cavity can be hobbed, the choice is restricted to hobbing steels. Because of their superior core strength, the alloy type hobbing steels are to be recommended if the hobbing shop feels it can handle them; otherwise, the plain carbon types must be used and there is little choice.

If production requirements are such that the mold must be run to destruction, the best materials should be used regardless of cost or ease of machining. In case of annual design changes, less durable materials can be used. On long run jobs of intricate shape, it is frequently cheaper to use hobbed cavities or beryllium copper cavities until they are no longer serviceable; replacement of these cavities is usually inexpensive.

When dimensional accuracy is of paramount importance, the air-hardening or hot work types are best because of their low dimensional change during heat treatment. For extremely large sections, carburizing types are favored because there is less danger of cracking in heat treatment.

Selection of materials for the balance of the mold does not present the problems involved in choosing cavity materials. Cleanliness and high polish are of little importance, and dimensional changes occurring in hardening treatments can be compensated for and corrected by grinding. In addition, there is none of the hand work which complicates cavity manufacture.

Transfer pots and punches require hard surfaces and high core strengths. Good oil-hardening steels or the alloy carburizing steels are commonly used. Cams for core pulls and moving parts of the mold are usually of an oil-hardening grade. Oil-hardening or hot work steels are used to prevent brittleness in machine nozzles and sprue bushings. Water- or oil-hardening steels are frequently used for backing plates.

Ejector pins are often made of carbon drill rod because this material is available in many diameters. But far better results are obtained from alloy steels such as Nitralloy, SAE 6150 or chisel steels. Tempered spring wire is an excellent material for pins ⅛ in. in dia. and smaller.

Grids or risers for compression molds are made of cast iron or steel; sometimes a welded machine steel construction is employed. Steam plates are made of machine steel or SAE 1040. The higher carbon steel is to be preferred because of its higher tensile strength. Injection molds are usually built up of machine steel, but the trend is toward a toughened steel, such as heat treated SAE 1040 or 6150.

Automatic Hard Facing Speeds Production Over Manual Methods

Where applicable, the use of submerged arc welding for hard facing will often result in lower unit costs and more uniform deposits.

by **WILLIAM PRICE**, Methods Engineer

& **C. V. FAAS**, Welding Engineer, LaPlant-Choate Manufacturing Co., Inc.

• WHEREVER LARGE quantities of parts require hard facing it is worthwhile to consider mechanizing the operation. Automatic hard facing can reduce cost per part because fewer operators are required. In addition, the hard facing is usually more uniform and the operation can be performed much more rapidly.

Engineers at LaPlant-Choate Manufacturing Co., Inc. have devised a means for automatic hard facing using a standard submerged arc welding machine. The parts being faced by this method are steel cutter bars used in earthmoving equipment.

Few pieces of equipment must withstand service conditions as severe as those to which cutter bars and teeth of earthmoving machinery are subjected. When several tons of soil and rock are to be lifted or pushed, the loading at the contact areas is high, and the force is usually applied with shock. In addition to the static and kinetic forces applied, abrasion is extremely severe. Cutter bars on bulldozers, for example, will be forced over and through sand and gravel with heavy pressure applied, and such service occurs not occasionally, but continually.

Shock loading on the bars requires that a certain amount of flexure be retained in the member so the body of the bar is of steel, and is given a spring temper. At the bottom edge of the cutter bar, which constitutes the cutting edge, a deposit of a hard-surfacing compound is laid down to provide the high resistance to abrasion needed at this part of the bar.

Hard-surfacing of steel cutter bars is an important operation at the LaPlant-Choate plant where daily production requires many such bars, in a range of lengths and thicknesses, all with a hard-faced cutting edge. The cutter bars range from 10 in. to 116 in. in length, and are made from 0.50 to 0.60% carbon steel. The hard-surfaced edge is usually about ⅞ in. wide, and laying down hundreds of inches of this facing by manual arc methods would be a tedious and time consuming operation.

Since the deposition is done along a straight line, it lends itself readily to mechanizing with the automatic equipment. Manufacturers of the hard facing rod have supplied the material as a coil of uncoated stock 3/16 in. in dia. for use with the Unionmelt machine. The hard facing wire is the standard #122 formulation of Stoody Co., and is a chromium-manganese-silicon - molybdenum - iron composition.

Hard Facing Procedure

Before hard facing, the steel that is used for the cutter bars is cut from multiple length bars to the lengths required. Cutter bars are made in a variety of sizes, ranging from 6 to 10 in. in width and from 10 to 116 in. in length, and with stock of from ½ to 1 in. thick. Flame cutting is used to cut the bar stock to the desired length. Square holes of the proper size are then punched through on a heavy punch. An indexing bar makes possible the rapid and accurate positioning of the holes by which the cutter bar will be attached to the earthmoving equipment. The holes are then countersunk on a four-spindle rail drill.

For the automatic hard facing, the bars are placed on a table with the edge to be hard surfaced resting against a copper strip. The table will accommodate one of the 116-in. bars, or several of those of shorter length. The copper strip serves as a flux retainer and as a stopper along the cutting edge, permitting the hard facing material to be laid at the extreme edge of the steel. Scrap steel blocks are likewise placed at both ends of the bar, or at both ends of the series of shorter lengths. This eliminates time consuming hand repairs at the ends of the bars, or the finishing of the ends of the bars by hand if the bead were started several inches from the ends.

Since there is always a tendency for the steel to warp during the application of the hard facing, the bars are clamped against a steel plate on the welding table and pneumatic clamps, spaced 18 in. apart, apply firm pressure.

The welding head is positioned over the point at which the bead will start, with the rod on the scrap steel at the end of the bar. The welding head is

mounted on a track that parallels the cutting edge. With a current of about 600 to 700 amp., the head travels along its track at the rate of about 19 in. per min., and a layer of hard material about ⅛ in. thick is deposited in one pass. The deposit is remarkably even in thickness and width, and only rarely does a defect require manual arc repair.

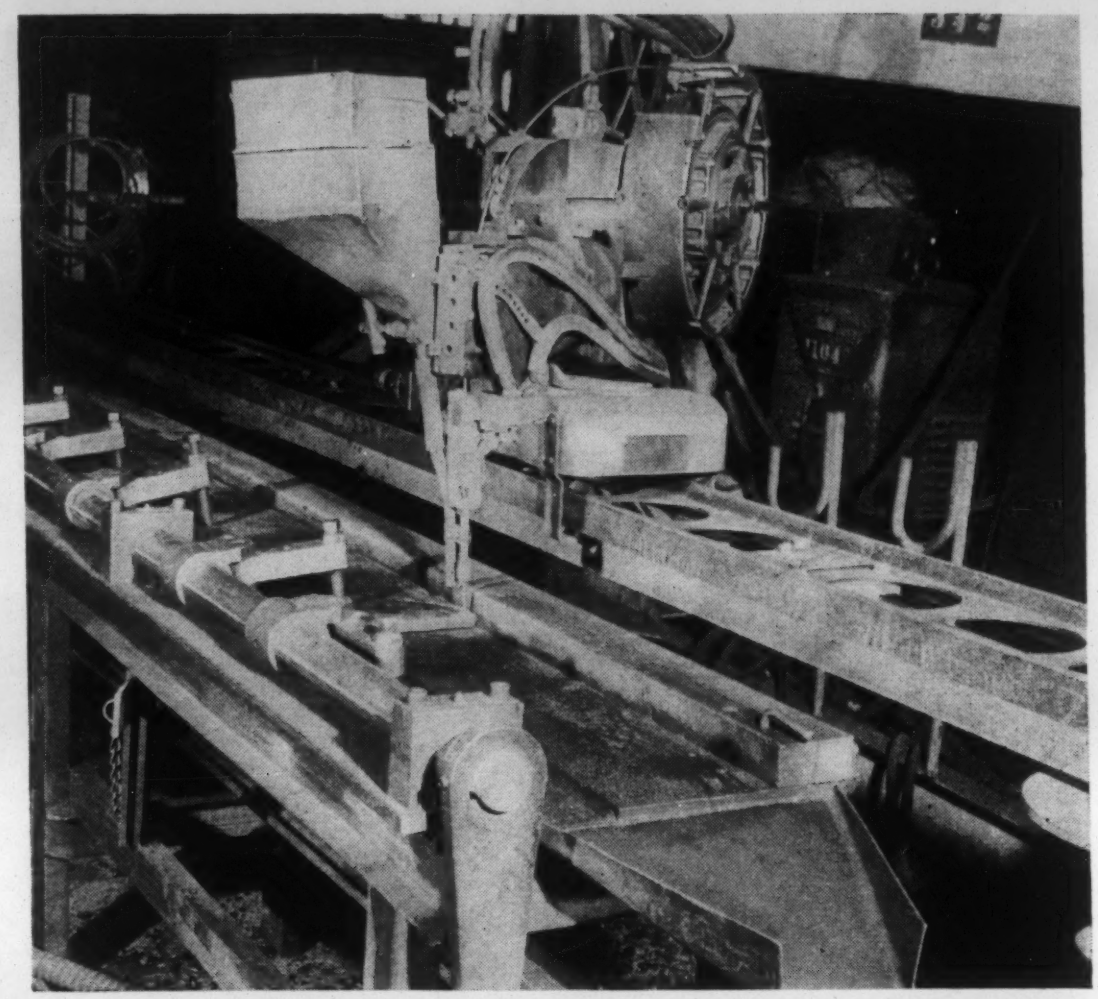
After the travel has been completed and the slag broken away, the bars are removed from the table and the ends are cleaned. If several short bars have been laid end to end on the table for continuous hard facing, the individual bars are broken apart. A stress relieving treatment in a furnace for 4 to 6 hr. at about 1250 F follows.

The final operation in the forming of the cutter bars is the beveling of the steel just behind the hard surfaced cutting edge, so that the bottom of the bar will be parallel to a theoretical soil surface when the bar is in its inclined working position. This is done in a Tractograph flame cutting machine with slight adaptations to get high production. The cutter bars are placed in two parallel rows, in a vertical position, and two cutting heads are used to make simultaneous cuts, one along each row. The heads are set at the angle desired in the beveled edge—about 25 deg.—and are so positioned that the bevel begins about ⅛ in. behind the layer of hard facing, so that there is a little steel behind the facing even at the extreme edge of the bar. In service the steel rapidly wears away, leaving a sharp edged bar with a hard surfaced edge. This method prevents any deterioration in the hard facing that might result from actual contact with the cutting flame.

The last operation consists of a heat treatment to develop best properties in the bar. The bars are heated in a furnace and quenched in oil to develop a hard spring temper in the steel, giving the hardness required along with good toughness. As they come from the heat treatment, ready for installation in earthmoving equipment, the bars possess the following hardnesses:

On hard surfaced edge:	R_c 52 to 54
On body of steel bar:	R_c 30 to 36

Cutter bars produced by this method have given excellent results in the field. Hardness is satisfactory, and the toughness of the part is adequate for the severe service. In the plant, the method makes for rapid production with standard equipment. The pieces are uniform and the production is efficient.

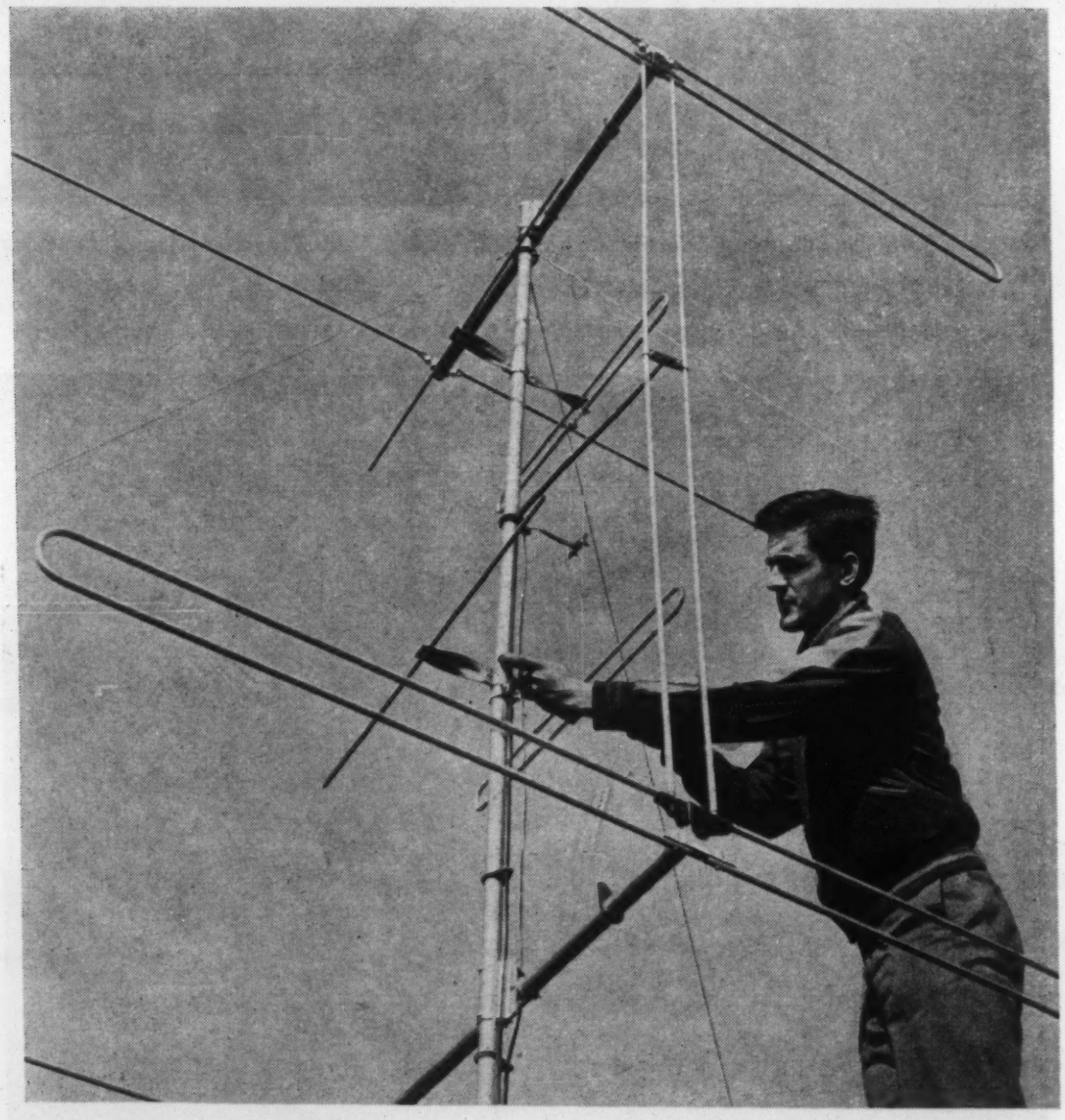


Shown here is the set-up used for automatic hard facing of cutter bars used in earthmoving equipment.

Hard facing metal is being deposited along the cutting edge of the steel cutter bars.

Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .

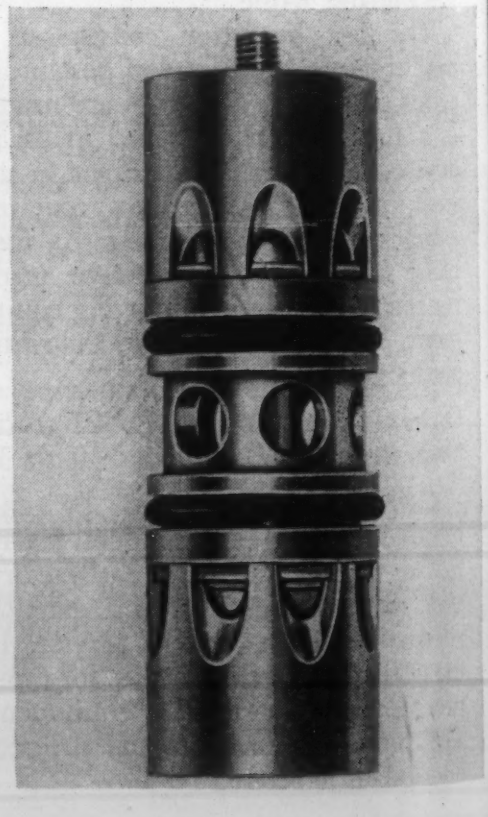


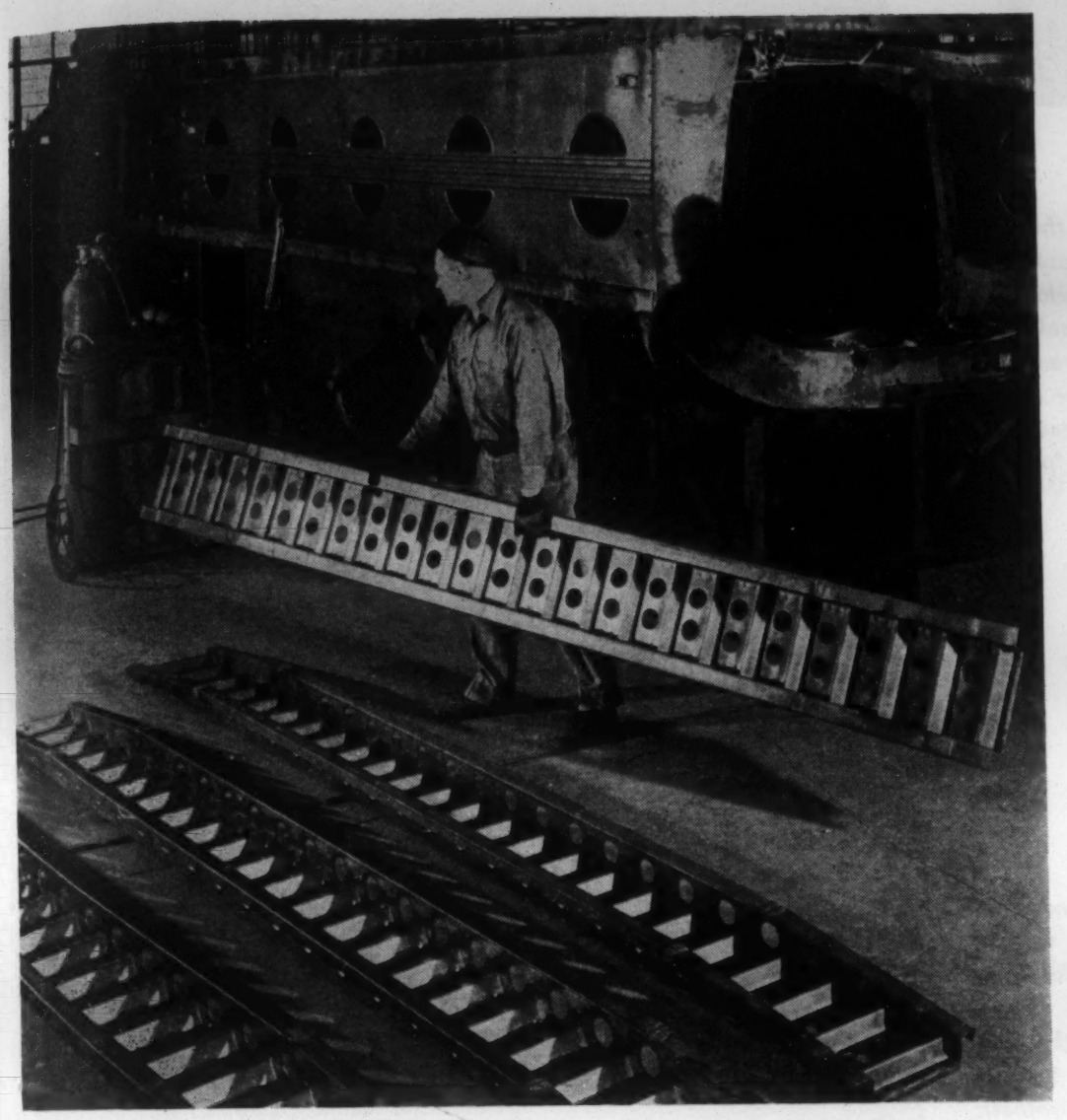
STEEL TUBE TV ANTENNA

Affording superior corrosion resistance and structural rigidity, the "Perma-tube" welded tubing produced by Jones & Laughlin Steel Corp. is currently used for television antennae manufactured by Ward Products Corp. This tubing is finished with a Vinsynite pre-treatment and a pigmented coating with a vinyl resin base. Under bending, expanding and other cold-forming, the "Perma-tube" finish flows with the metal and does not chip or flake off within the limits of distortion of the steel. The outstanding deflection value of the steel, contrasted with aluminum, reduces antenna vibration, which causes distortion of the image on the television screen. The new antenna material also has greater wind strength and can carry higher ice loads than antennae of less rigid metal. All sections and attachments of the antenna are joined mechanically by inserting, clamping or bolting. The installed assembly will stay tight, as the metal will not flow or work loose once the sections are joined.

CORROSION RESISTANT AIR VALVE

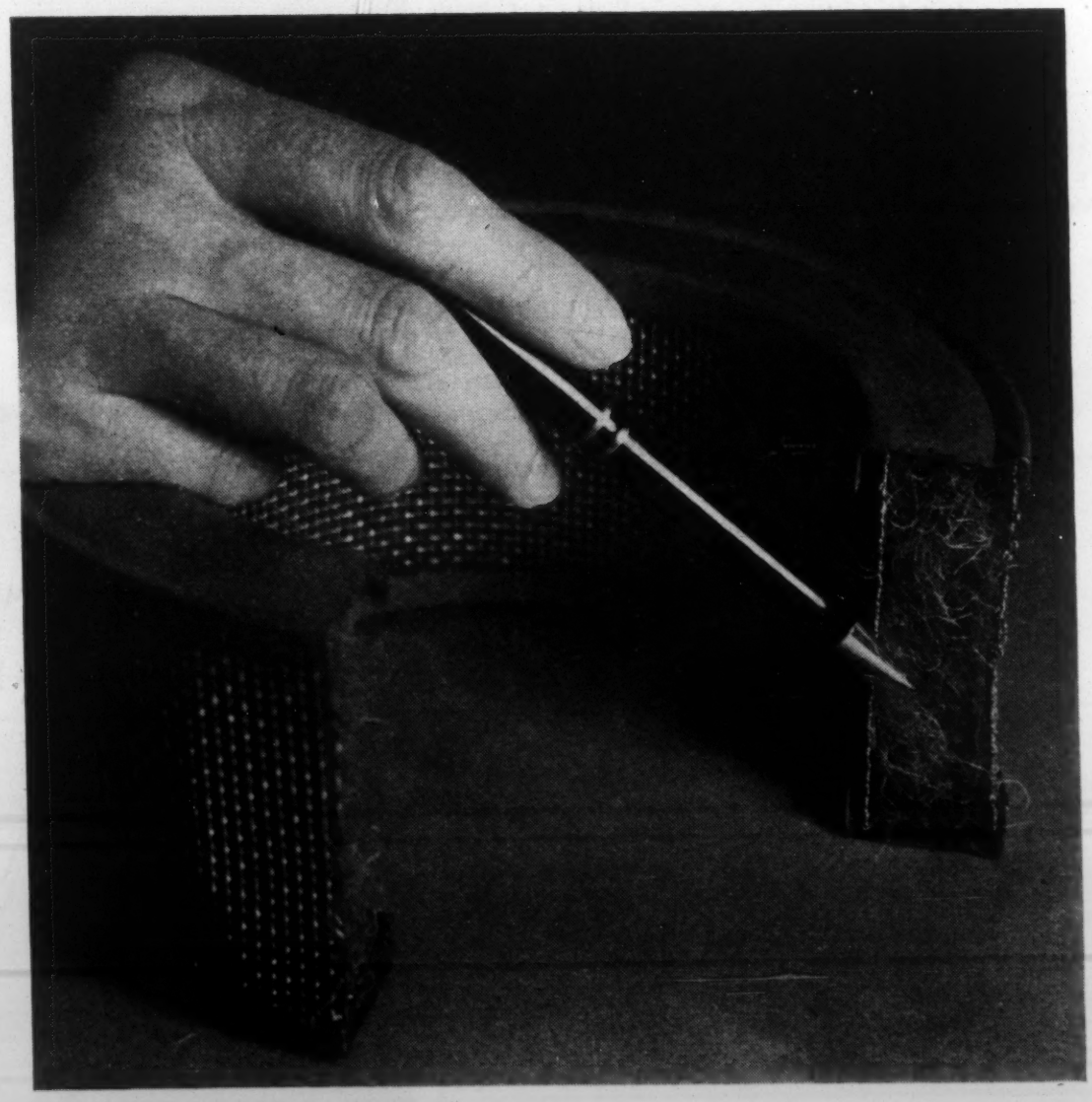
The solenoid-operated air valve below is manufactured by Viking Products Co. of corrosion resistant metals, incorporates a Neoprene rubber gasket, and has the added advantages of long life, interchangeability, ease of installation, and fast, reliable action. The "Ring-Seal" valve, a 3-way or 4-way, 3-, 4- or 5-port assembly, has components of stainless steel and bronze and operates smoothly at speeds as high as 600 strokes per min. It is designed for air pressures to 105 psi. and for operation on 110-v. a.c. 60-cycle current. The valve assembly is removable from the housing at either end without disconnecting any piping.





HIGH STRENGTH STEEL SKIDS

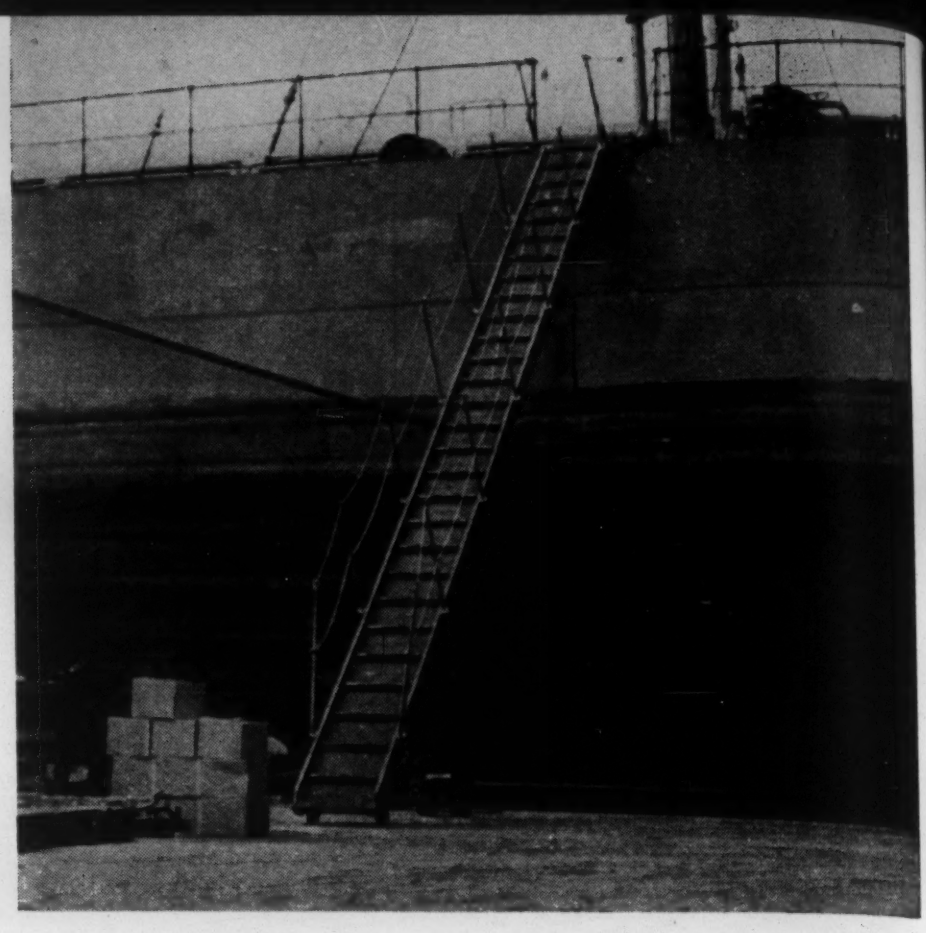
Designed to reduce deadweight during haulage and at the same time withstand shock loads during loading and unloading operations, these skids for automobile haulaway rigs are produced by Mechanical Handling Systems, Inc. of Jones & Laughlin Otiscoloy high strength steel. The skids have 18-gage high strength steel treads resistance welded to side channels of 12-gage steel. This construction results in a 12-ft. skid which weighs approximately only 100 lb.



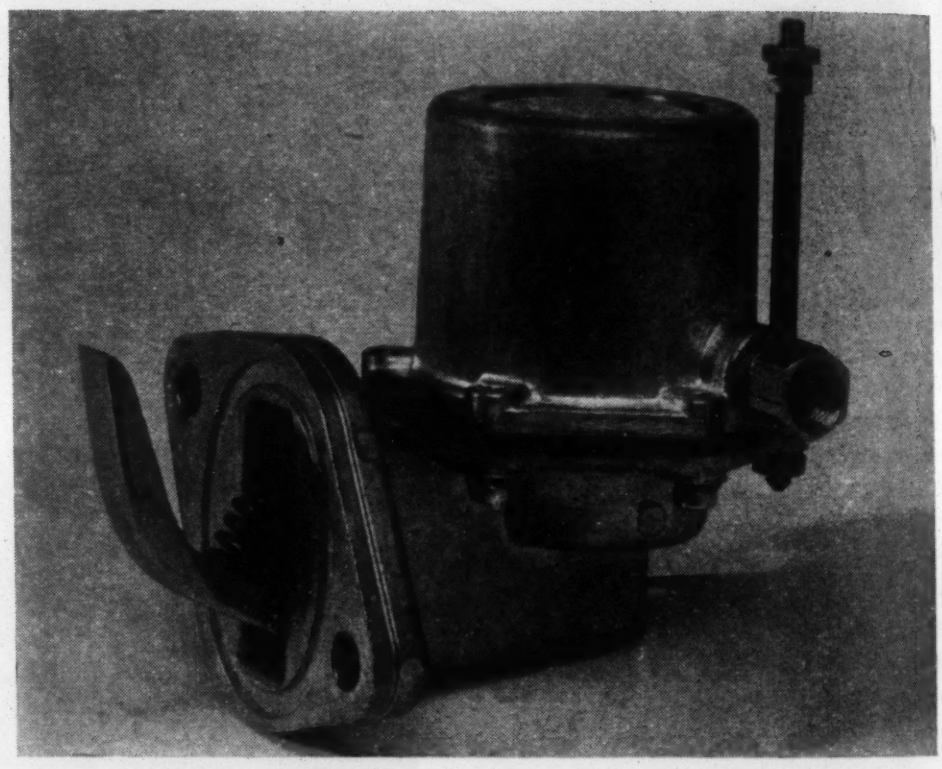
SYNTHETIC FIBER AND WOOL FILTER

Supplanting the fine copper turnings customarily used in filters of this sort, a new material composed of casein fibers and pure wool impregnated with tricresyl-phosphate is used in the carburetor air filters produced by the Fram Corp. These synthetic fibers, produced by Rubberset Corp., and known as Caslen, provide such controllable features as length, diameter and tightness of curl to assure interlocking of the finished material and to prevent matting. Bats of the fiber and wool composition are tightly packed in the metal filter cartridge screen and assembled to the standard carburetor resonating chamber in the conventional manner. The new type filtering material should not be washed in gasoline, kerosene or solvents, and should not be oiled as the conventional copper filters are.

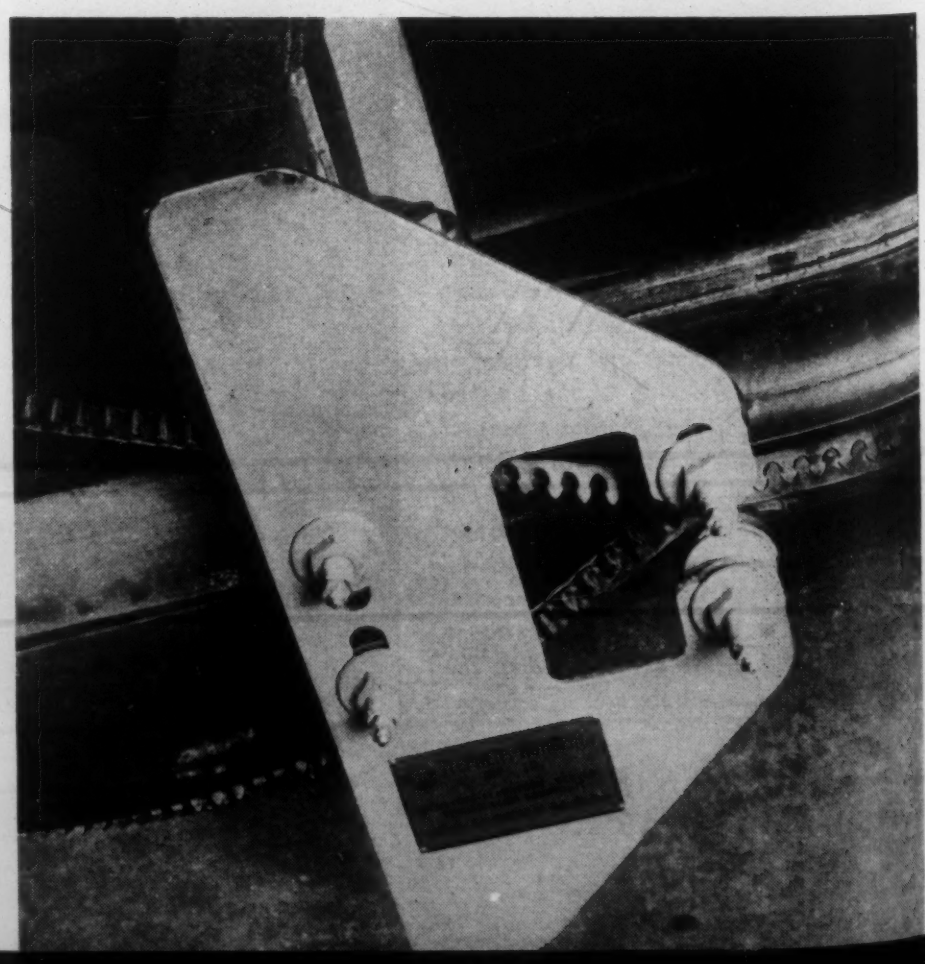
Materials at Work



MAGNESIUM GANGPLANK *Replacing the crude, heavy, wooden structures conventionally used, this lightweight magnesium gangplank was developed by Magnesium Co. of America for sea-going tanker use. Retaining all the advantages of its wooden predecessor but reducing weight from 1200 to 500 lb. for a 36-ft. length, this magnesium innovation is currently produced in a variety of types and lengths for every maritime requirement.*



DIAPHRAGM-TYPE FUEL PUMP *A newly-designed fuel pump utilizing a single, soft-type valve of synthetic rubber for both the inlet and outlet sides, instead of the two or more hard-type valves conventionally used, is currently in production by the F. L. Jacobs Co. for use in limited quantities in taxicabs made by Chrysler Corp. Pliability of the synthetic rubber valve provides easier maintenance of vacuum or pressure than if a hard-type valve is used. In addition, the pump has two large equalizing domes, one on the inlet and one on the outlet side, to maintain a more even and constant flow of fuel through the pump.*



RUBBER "ZIPPER" BELTS *Rubber belting equipped with molded-in "zipper" teeth, and designed for conveyor-elevator handling of bulk foods, chemicals, unfired ceramic pellets, or any granular, flaky, or pulverized material without breakage or contamination are produced by B. F. Goodrich Co. for Stephens-Adamson, manufacturer of the "zipper" belt conveyor. The belt can travel horizontally or vertically, on slopes and curves, and is extremely adaptable where space is limited. The rubber teeth on the belt can be locked or unlocked at any point by use of rollers which operate on the same principle as the tab on a conventional slide fastener. The rubber teeth have the advantage of extreme flexibility, resistance to shock and wear, and noiseless operation. Power consumption compares favorably with conventional belt conveyors and is well under the average for most types of elevators by virtue of its simplified design and lightweight materials.*

Transparent Plastics Compete with Glass in Many Applications

Because of their clarity, flexibility and formability, glasslike plastics are finding use in many fields where glass was formerly the only material available.

by **KENNETH ROSE,** Western Editor, Materials & Methods

• GLASS HAS for centuries held a place almost unique among materials because of its transparency. A glance at the list of crude glazing materials other than glass that have been used of necessity—oiled paper, dried fish membranes, oiled skins of animals, mica, etc.—shows the preeminence of glass in this field. Truly, glass has stood practically alone as a transparent material for glazing and for industrial use.

Glass, however, has some limitations, the most important one being its frangibility. Ceramics engineers and research workers have sought a means of producing flexible glass for centuries, without real success. The development in recent years of glass so heat treated as to possess high strength under certain conditions has been a real step forward, and the laminated glass in which shattering is practically eliminated by a plastic interlayer is another approach to the problem. Neither development, however, has solved the problem of the inherent weakness of glass to localized impact.

The development and production of plastics has brought to the materials engineer the first real competitors with glass in clarity. Fused quartz and certain minerals, such as calcite and fluorite, have found a limited use in optics for windows in furnaces, for laboratory ware, etc., but they have always been special purpose materials of sharply limited utility. With the development of plastics of good clarity, many fields where glass had been without competition are now giving the new materials consideration. In addition, new fields have been opened to the new transparent materials because of their flexibility, formability, or for other reasons.

Plastics having this quality of excellent transmission of light are found among both the thermosetting and the thermoplastic types. Because of considerably greater ease of forming, and better stability of the clarity of the material, the thermoplastics are favored among the clear types. All of the transparent thermosetting types show a tendency to yellowing that so far has not been completely overcome.

Glass and Plastics Compared

For the sake of comparison, some of the properties that make glass a valuable material in industry are:

(1) It can be produced in a very high clarity. The chemistry and techniques of glassmaking are now well understood, and the faint coloration that was once a residual from the metallic oxides can be almost completely removed. Compounds of manganese are the principal decolorizers for glass.

(2) It possesses good resistance to distortion at elevated temperatures. Glass softens gradually at temperatures above about 700 to 800 F for "soft" glass, higher temperatures for the boro-silicate or other heat resistant glass. Mild steel begins to soften, or lose strength, at about the same temperature range.

(3) It shows excellent resistance to chemical attack. Only hydrofluoric acid and strong caustic alkalies will attack it.

(4) It has a high hardness, equal to the hardness of spring steel. This is of great value in maintaining clarity, as the effect of tiny scratches is first to produce "haze."

(5) The index of refraction is controllable within limits. This is of importance to the optical industry.

(6) It can be fabricated by a wide range of hot-forming methods. Molding, blowing, welding, pressing, etc., are well adapted to processing of glass.

(7) It can be metallized by the mirror reaction, or by other methods.

A few of its disadvantages are:

(1) It is rather heavy. Specific gravity is about 2.8 for common types of glass.

(2) It is frangible. The readiness with which glass shatters at a blow is one of its worst disadvantages.

(3) It is quite notch-sensitive.

(4) It cannot be cold-formed, except by cutting or grinding.

(5) Riveting and bolting are not generally successful.

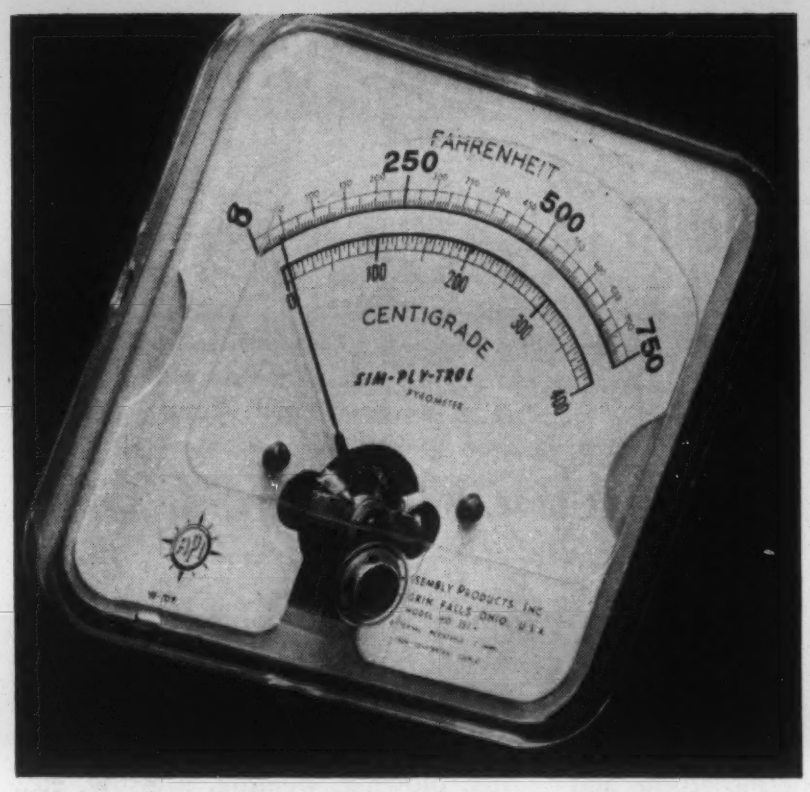
The glasslike plastics, in contrast, have the following properties:

(1) Some types are capable of an optical clarity rivalling that of glass. Certain of the allyl polyesters, the methyl methacrylates, and the polystyrenes have been used for lenses and prisms in binoculars, and for similar purposes having rigid optical requirements.

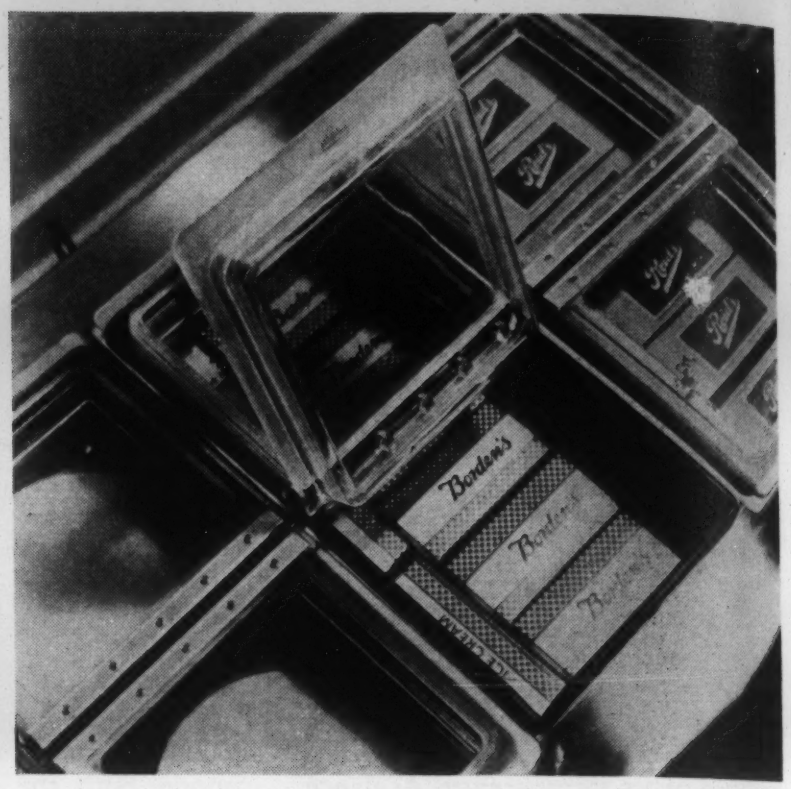
(2) Chemical resistance is variable, but is generally much inferior to that of glass.

(3) The weight of all types is lower than that of glass. This feature, along with the ease of forming the plastics sheet into complex shapes, is its greatest advantage for aircraft glazing. As the glasslike plastics enter the container field as containers or closures, the saving in shipping costs combined with reduced breakage become important factors.

(4) Elevated temperature resistance is far below that of glass. The thermoplastic types usually start softening at about 130 to 140 F, and even the translucent thermosets are



Both excellent clarity and heat resistance are features of this pyrometer case of polystyrene. (Courtesy Koppers Co., Inc.)



Lids for ice cream cabinets are made of clear acrylic, 2 in. thick. (Courtesy Rohm & Haas Co.)

not recommended for service much above 210 F. Recently several important new polystyrenes with resistance to temperatures well above 200 F have been announced, and there are heat resistant grades of methyl methacrylates that are usable to about 200 F.

(5) All of the plastics under consideration are much softer than glass. This is one of the most important limiting factors when plastics are considered for glazing, as it means a rapid increase in the haze value during service, due to tiny scratches over the surface.

(6) All of the glasslike plastics are breakable, but are not shatterable to the same extent as glass. This is another feature that has given certain of the clear plastics an advantage for glazing of aircraft, especially military aircraft.

(7) The plastics are more easily formed than glass. They can be hot formed, at very moderate temperatures, machined, ground, polished, welded, adhesion-bonded, riveted or bolted, etc. A valuable feature of the thermoplastic types is their adaptability to pneumatic forming, with or without molds.

Kinds of Glasslike Plastics

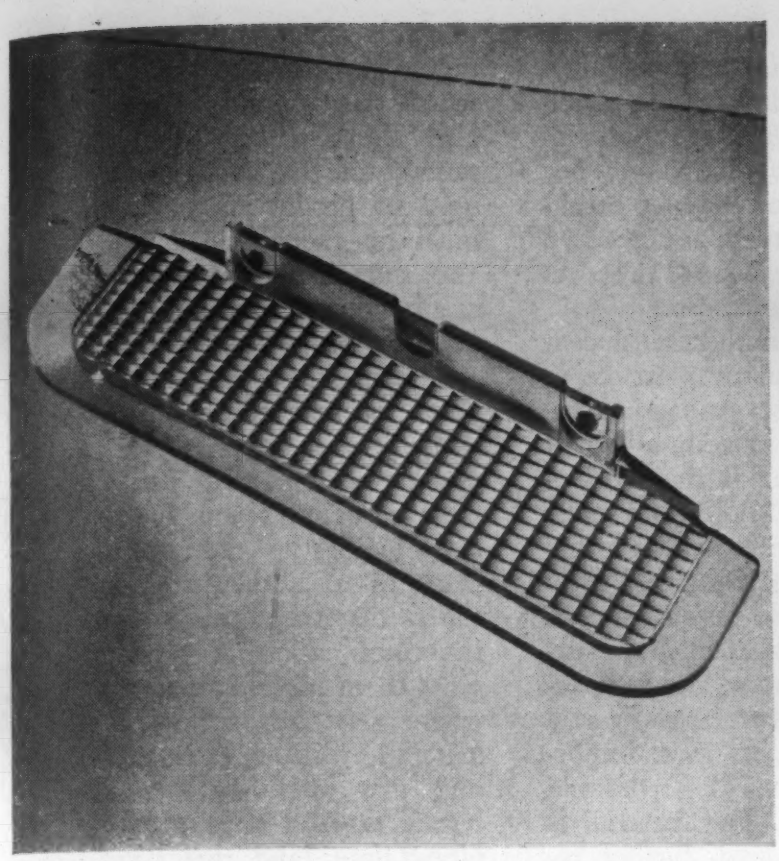
The most important glasslike plastics are those of high clarity that are suitable for certain types of glazing and for optical use. These include some allyl polyesters, the methyl methacrylates, and some polystyrenes.

Allyl Polyester—Allyl polyester resins are especially adapted to low-pressure laminating, but when used as a glasslike material, they are usually cast in sheet, rod or tube form, or in more intricate form. Since they are thermosetting, when polymerization is completed in the mold the material is left in an infusible form. In the case of the allyls, however, the material can be heated and postformed to some extent. Molds should be of iron or steel, aluminum, the fusible alloys, glass, and glazed ceramics; copper, brass and rubber must be avoided, as they tend to inhibit polymerization. Polymerization takes place at moderate temperature and without use of pressure, in the presence of a catalyst, so that no complicated, expensive equipment is needed.

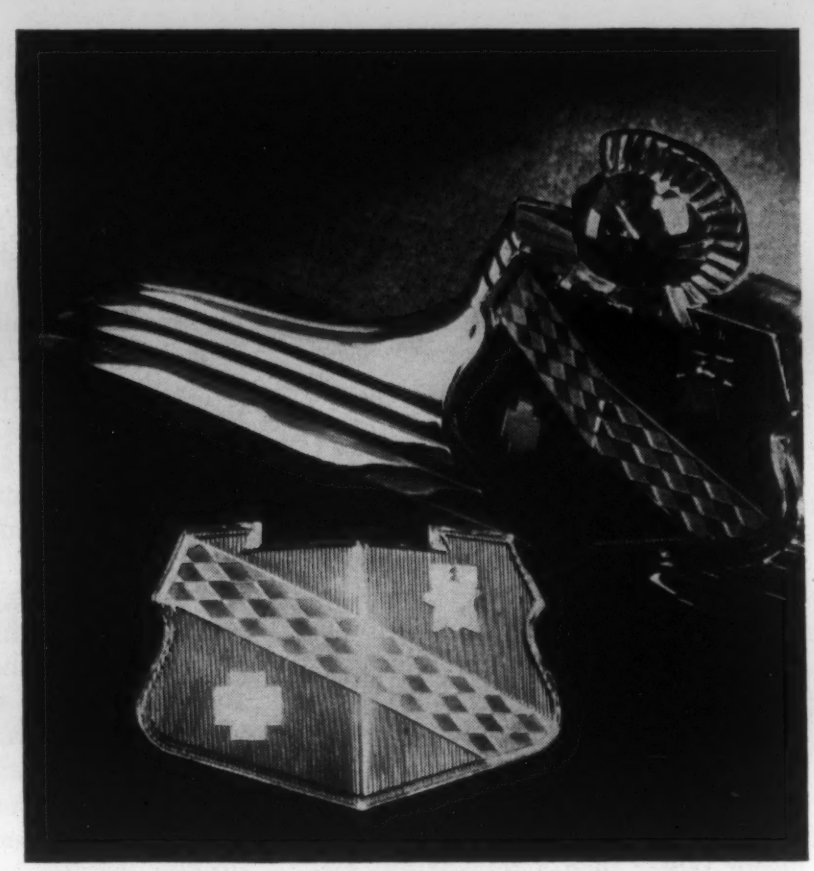
The plastic shows excellent chemical resistance, heat resistance to about 210 F, good surface hardness, and high clarity. There is sometimes a tendency to develop a slightly yellow tinge. Allyl polyesters find use in transparent enclosures for aircraft, covers for dials and indicators, cast lenses and prisms, television lenses, de-icer windows, etc. Incorporation of a pigment for absorption of some of the sun's rays makes the material for sun visors. Phosphorescent or fluorescent materials can be used to obtain novelty effects in signs.

Methyl Methacrylate — The methyl methacrylates were the first of the plastics of brilliant clarity to be offered to industry. They are materials of unlimited color possibilities, and have good optical properties generally. They still possess the best resistance to deterioration by sunlight and weather. Being a thermoplastic, the general purpose material is suitable for use in temperatures up to about 140 F, while a heat resistant grade is usable at temperatures about 50 F higher. The resin can be cast or molded. In the case of molded parts, the quality of the surface of the piece, and therefore its clarity, is largely dependent upon the surface of the mold and upon careful molding procedure. The heat resistant grade is somewhat more difficult to mold than the general purpose material.

In addition to the molded material, cast sheets can be formed at moderate temperatures. In order to preserve the optical qualities of the material when formed into such pieces as aircraft enclosures, the sheet is frequently blown to form by air pressure, without the use of a mold of any sort. Blowing a slight convexity into a small sheet of the acrylic can produce a piece from which a curved door for aircraft can be cut, while blowing a large bubble



An intricate prism molding is obtained at low cost using polystyrene for this refrigerator light deflector. (Courtesy Koppers Co., Inc.)



Glasslike molded acrylic medallion for automobile radiator grille. (Courtesy Rohm & Haas Co.)

from a heated sheet may give the basic form to a gun blister or a cabin enclosure. In either case the air is admitted slowly under the sheet as it is held in a fixture, and the heated plastic gradually expands to the desired form. Only about 2 psi. of air pressure is needed. Careful control of the temperature of the plastic and of the rate of forming will prevent striations developing in the material.

Another property of the acrylics that is much used in display is its ability to "pipe" light. Internal reflections in a tube of the material cause a beam of light to follow turns in the tube, thus transmitting the light along a fixed path, straight or curved. Surgical instruments make use of this property of the acrylics also. In addition to store display easels, in which brilliant edge-lighted effects can be obtained, the principle is finding some use in outdoor signs. Fluorescent and phosphorescent pigments can be incorporated into the plastic when desired. It can also be metallized for mirror effects, or for the metallic appearance itself.

Methyl methacrylates are used in lenses for protective goggles, transparent figures for sales display, transparent models of mechanical parts for study or demonstration, television lenses, for decorative parts of coin machines, drafting equipment, reflectors, name plates, automobile and aircraft panels, dial covers, household appliances, etc.

Polystyrene—The polystyrenes are in the favorable position of possessing a combination of desirable properties, and of being low in price. They are brilliantly clear, optically satisfactory, and are highly resistant to acids, alkalies, alcohol, and many organic solvents. In addition, they are practically impervious to water, have good dimensional stability, are one of the lightest of the plastics groups, are free from taste or odor, have good low-temperature properties, and can be produced in heat resistant types suitable for use to about 210 F or higher. They also have a wide range of fabricating possibilities, with excellent moldability, even in the heat resistant grades. Like the acrylics, the polystyrenes possess the property of piping light.

Not all grades of polystyrene are clear water-white, so it is necessary to specify the high-clarity material when it is wanted. Polystyrene is one of the most versatile and widely used general purpose thermoplastics, and the end use for which the material is intended should always be specified so that the most suitable grade will be obtained. Polystyrene plastics have been used successfully for lenses and prisms in lightweight binoculars, for bottles and bottle closures, for glasslike kitchen and household gadgets, wall tile, light fixtures, etc.

Cellulose Nitrate—Cellulose nitrate was the first of the modern glasslike plastics made available to industry. It is transparent but tends to darken, especially upon exposure to sunlight. It found an early use in transparent panels in the cloth and leather tops for carriages and automobiles. This material tended to yellow badly due to the slow liberation of acids and oxides of nitrogen. Addition of acid acceptors to the formulation greatly decreased the yellowing. Cellulose nitrate is a thermoplastic and is one of the toughest of the plastics, and this toughness combined with transparency is utilized in lenses for flashlights, visible ink chambers for fountain pens, etc. Its transparency is an advantage for such drawing instruments as triangles and curves.

Cellulose Acetate—Cellulose acetate, another early arrival, is available in various types capable of good transparency. With cellulose acetate the tendency to darken had its origin in secondary contamination of the materials, and improvement in (a) the purity of the chemicals themselves, (b) the materials in the plant equipment, and (c) plant techniques, with special emphasis upon cleanliness, brought about substantial lessening of discoloration.

Cellulose acetate can be varied in its properties by control of the viscosity of the acetate itself, and by varying the type and amount of plasticizer used. Suitable formula-

tions are used for sunglass lenses, lamp shades, etc. While the acetate possesses better resistance to sunlight than the nitrate, it has rather poor resistance to cold flow. An aircraft grade has been developed for aircraft glazing. Properties of the acetate butyrate are much like those of the acetate, while the propionate shows superior physical properties, especially in impact resistance and dimensional stability, but is not produced in transparent form.

Ethyl Cellulose—Ethyl cellulose, a thermoplastic, is available in transparent grades. It has excellent impact resistance and low-temperature properties, and dimensional stabilty is maintained even in excessively moist air. It goes into transparent flashlight cases and lenses, fountain pen barrels, transparent radio panels, etc. Another glasslike thermoplastic resin is cellulose propionate. It is a translucent rather than a transparent material with excellent strength properties.

Melamine- and Urea-Formaldehyde—The melamine and urea thermosets are not available as clear materials but they are translucent. They are included in this group of materials only because they are widely used as a substitute for opal glass and for lamp shades and other translucent pieces in competition with glass. These plastics have excellent color stability, and show no significant tendency to yellowing. They have light weight and lessened breakage to recommend them as compared to glass. These materials are favorites for translucent buttons also.

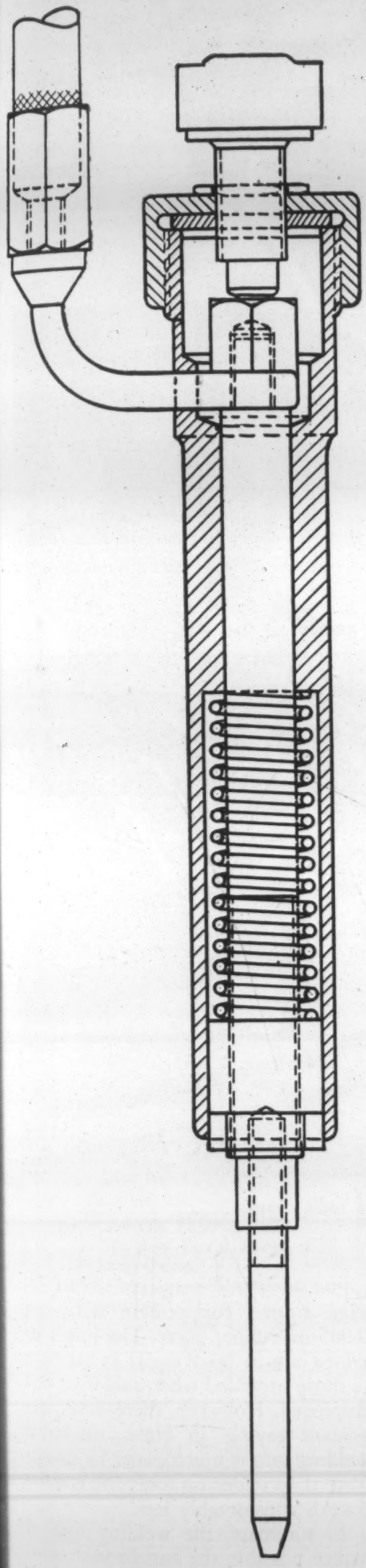
Polyethylene—Another translucent material not particularly glasslike in its properties, but becoming increasingly important as a competitor of glass in several uses, is the thermoplastic polyethylene. It has unusually good chemical resistance. Strong acids and alkalies, alcohol, and most organic solvents have no effect upon polyethylene. It has excellent resistance to moisture vapor, and is tasteless and ordorless. Insofar as it is a competitor of glass, its most important uses are in tumblers, bottles and shipping containers. The material is slightly flexible as used, further reducing the danger of breakage, and making possible such specialties as the squeezable bottle.

In addition to the above transparent and translucent materials, many of the vinyl polymers and copolymers are translucent. They are not given separate listing here because their applications are seldom in fields where they are chosen for their glasslike properties, or in which they are in competition with glass. Polyvinyl butyral, the most important of the laminating materials used in production of safety glass, must be mentioned in this group also, though it is chosen for this use as a bonding agent rather than for its glasslike properties.

The glasslike plastics, then, have given the materials engineer his first really clear material for product fabrication that will compete with glass in some respects. No one of the glasslike plastics could completely replace glass. Rather, they are high-clarity materials offering an interesting combination of properties that gives them preference in some fields where glass was formerly the only material available, as in aircraft glazing; that opens new fields, as in certain types of novelty display using piped light; and that constitutes a minor material in some fields where glass has long been established and still has preponderant advantages, as in bottles. In still other fields, glasslike plastics remain materials not in practical use, but available as possible future contenders if the cost picture should change or some unsatisfactory property be improved.

General Properties of the Glasslike Plastics

Resin Type	Trade Names	Haze Value, %	Refractive Index	Luminous Transmittance, %	Specific Gravity
Allyl Esters	Selectron, Kriston (production halted, at least temporarily)	1 to 2	1.50-1.57	90-92	1.30-1.40
Methyl Methacrylates	Lucite, Plexiglas	1 to 3	1.485-1.50	91-92	1.18-1.19
Polystyrenes	Bakelite, Loalin, Loalex, Styron, Lustron, Lustrex, Cerex, Plexene, Koppers, Chemaco	5 to 10	1.59-1.60	93	1.05-1.065
Cellulose Nitrates	Pyralin, Nitron, Nixon C/N	2 to 4	1.49-1.51	89-92	1.35-1.40
Cellulose Acetates	Hercules, Koppers, Chemaco, Lumarith, Tenite I, Plastacele, Fibestos, Nixon C/A	3 to 8	1.46-1.50	80-90	1.27-1.33
Cellulose Acetate Butyrates	Tenite II	3 to 10	1.46-1.49	80-95	1.19-1.23
Ethyl Celluloses	Ethocel, Hercules, Chemaco, Koppers, Celcon, Nixon E/C	—	1.47	—	1.10-1.14
Cellulose Propionate	Forticel	—	1.47-1.48	—	1.16-1.21
Polyethylenes	Bakelite, Polythene	—	1.51	—	0.92
Urea-Formaldehydes	Beetle, Plaskon	—	—	—	1.47-1.52
Melamine-Formaldehydes	Melmac, Plaskon, Resimene	—	—	—	1.47-1.52



Sectioned view of welding gun.

Joining Parts to Passivated Zinc Surface Accomplished Through Resistance Welding

This new, rapid spot welding method solved a difficult joining problem and permitted the use of more economical finishing methods.

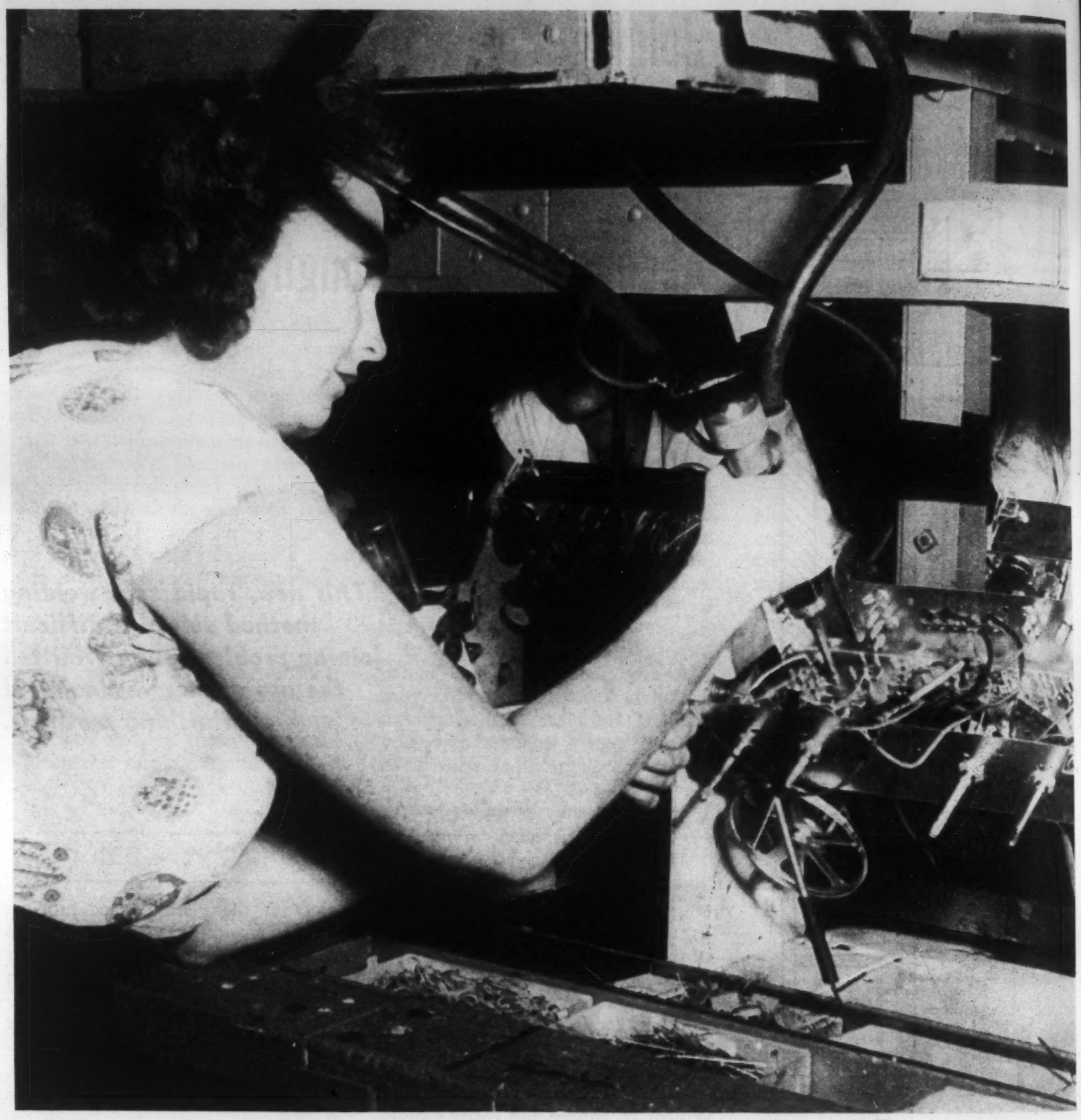
• AN INGENIOUS resistance welding method developed by engineers of the Electronics Park plant of General Electric Co., Syracuse, N. Y., seems to offer interesting possibilities to others faced with difficult joining problems. The method is possible through the development of a spring actuated hand gun which is convenient to handle and easily manipulated.

The welding method was developed to overcome problems encountered in soldering small parts to passivated zinc-plated steel radio chassis. A combination of circumstances made it more desirable to change joining methods than to use a different method of finishing the steel chassis.

In quality radio sets it is desirable that the steel chassis remain free of corrosion and discoloration for the life of the set. For some time the desired finish was obtained by plating the steel sheet of the chassis with cadmium. However, the high price of cadmium as opposed to many other plating materials led to the use of zinc for the plating. Zinc provides good corrosion resistance, but has a tendency to discolor, particularly where it has been touched by human hands. As a solution to the discoloration problem, a passivating treatment was decided upon for the zinc surfaces. For this purpose Luster-on, manufactured by the Chemical Corp., is used.

The solution of the finishing problem led to a new set of problems. It is more difficult to solder to the passivated zinc surface. Soldering can be accomplished by the use of a special flux, and the corrosive residue can be evaporated if the iron is operated a little hotter than usual. This method is satisfactory for many manual operations. However, the intricate assembly line at General Electric made it necessary to preplace the spots of solder on the radio chassis and then, before assembling, the entire unit was cleaned to make certain that no flux remained. This was both costly and time consuming, so a cheaper, faster method was sought.

The resistance welding method



The gun is shown here in the actual operation of spot welding on a radio chassis.

finally developed utilizes a standard Thryratron control panel and operates on either 220- or 440-v., single-phase current. The ground lead of the welder is attached to the chassis upon which welding is being done. Welding current is applied by pressing the tip of the welding gun against the materials between which a joint is desired. In some cases a foot pedal is provided for those circumstances where two welding heats are required. The use of the gun alone will provide the low heat current, and by simply stepping on the foot pedal a higher heat is provided. The low heat is used when attaching tinned wire to the chassis and the higher heat is used for the attaching of copper strip.

The welding gun, a sketch of which accompanies this article, is composed of a handle within which is placed a welding electrode having a ⅛-in. tungsten tip. When the gun's tip is pressed against the spot where a joint is desired, the pressure causes a spring to actuate a microswitch, which closes the welding circuit. Release of the pressure again opens the circuit.

On the production lines where such devices are now being used, joints are made between 18- to 22-gage tinned copper-base wire and 0.005-in. copper sheet. The joints attained are at least equal in strength to those provided when soldering was employed. However, there is an important saving in time, since the welding gun is much easier to manipulate than soldering tools and heating time is considerably less.

In summary, the welding method makes possible the use of more economical and highly satisfactory finishing methods, plus being much faster from a production standpoint than the soldering formerly used.

Materials Engineering File Facts

NUMBER 182
November, 1949

MATERIALS DATA SHEET

Wrought Magnesium Alloys

Typical Properties

Property \ ASTM / Am. Mag. Corp. / Dow Chemical Co.	MI AM3S M	AZ31X AMC52S FS-1	AZ61X AMC57S J-1	AZ80X AMC58S – F O-1 HTA	TA54 AM65S D
COMPOSITION, %	Mn, 1.20 min. — —	Al, 2.5-3.5 Zn, 0.6-1.4 Mn, 0.20 min.	Al, 5.8-7.2 Zn, 0.4-1.5 Mn, 0.15 min.	Al, 7.8-9.2 Zn, 0.2-0.8 Mn, 0.12 min.	Al, 3.0-4.0 Sn, 4.0-6.0 Mn, 0.20 min.
PHYSICAL PROPERTIES					
Density, Lb./Cu. In.	0.064	0.064	0.065	0.066	0.067
Melting Temp. Range, F	1200	1050-1170	950-1140	900-1115	—
Thermal Cond., Btu./Hr./Sq. Ft./Ft./F, (212-572 F)	72.6	55.6	46.0	43.5	—
Coeff. of Exp. per F: 65 to 212 F	1.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}
65 to 750 F	1.6×10^{-5}	1.6×10^{-5}	1.6×10^{-5}	1.6×10^{-5}	1.6×10^{-5}
Spec., Ht., Btu./Lb./F (78 F)	0.25	0.25	0.25	0.25	0.25
Elect. Res., Microhms/Cm./Cm.^{2}, (Wrought, 68 F)	5.0	10.0	12.5	14.5	13.8
MECHANICAL PROPERTIES					
Modulus of Elasticity, Psi:	6.5×10^6	6.5×10^6	6.5×10^6	(see Note 1) 6.5×10^6	6.5×10^6
Tensile Str., 1000 Psi:					
Extruded[2]	26-38	35-39	40-45	40-49	—
Forged	36.0	—	43.0	46.0	40.0
Yield Str., 1000 Psi:					
Extruded[2]	23-28	23-28	22-32	23-35	—
Forged	23.0	—	26.0	31.0	28.0
Elongation, % (in 2 In.):					
Extruded	8-11	12-18	15-16	10-12	—
Forged	7	—	12	8	12
Compressive Yield Str., 1000 Psi:					
Extruded[2]	10-13	15-17	15-21	21-26	—
Forged	—	—	18.0	25.0	21.0
Hardness, Bhn.:					
Extruded[2]	42-46	49-50	55-60	60-67	—
Forged	47	—	55	69	52
Shear Str., 1000 Psi:					
Extruded	16.0	19.0	21.0	21.0	—
Forged	16.0	—	21.0	22.0	16.0
Fatigue Str., (End. Limit), 1000 Psi:					
Extruded	9.0	14.0	17.0	19.0	—
Forged	—	—	16.0	18.0	11.0
Impact Str., (Charpy), Ft.-Lb.:					
Extruded	2.1	3.2	3.0	2.2	—
Forged	—	—	2.2	1.8	2.0
THERMAL TREATMENT					
Annealing Temp., F	700	650	650	725	650
Extrusion Stress Relief Temp., F	500	500	500	400	—
Solution Temp., F	—	—	—	750	—
Aging Temp., F	—	—	—	350	—
Extrusion Ht. Treating & Aging Temp., F	—	—	—	600	—
FABRICATING PROPERTIES					
Hot-Working Temp. Range, F	550-650	450-650	450-650	275-375	450-820
Shortness Temp., F	—	820	780	775	850
Max. Red. between Anneals, %	20-25	20-25	—	—	—
Weldability:[4] Torch	A	B	C	D	B
Inert Gas Arc	A	A	A	C	C
Elect. Res.	A	A	A	A	B
Machinability Index (Free-Cutting Brass = 100)	500	500	500	500	500
Formability:[4] Hot	A	A	B	C	B
Cold	B	A	C	D	C
CORROSION RESISTANCE					
Resist. to Atmosphere	High	High	High	High	Good
AVAILABLE FORMS	Sheet, plate, rod, bar, extruded shapes, tubing, extruded hollow shapes.		Rod, bar, extruded shapes, tubing.		Rod, bar.
APPLICATIONS	Sheet, extrusions	Sheet, extrusions	Extrusions, forgings	Extrusions, forgings	Forgings
	Aircraft frame parts, textile, other high-speed reciprocating machinery, truck bodies, jet engine parts, etc.				

NOTES: [1] *Tensile, tensile yield and compressive yield strengths, and hardness of AZ80X can be increased several per cent by heat treating at some expense to the elongation.*
[2] *Generally, strengths and hardness of extruded bar are highest, extruded tubing lowest, and extruded shapes intermediate in the ranges of values given.*
[3] *Higher working temperatures can be used when heating hard rolled or aged alloys above the annealing or aging temperature is not involved.*
[4] *Letter A indicates most favorable property, D least favorable, etc.*

Prepared with the assistance of Dow Chemical Co. and American Magnesium Corp.

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DIMENSIONAL ACCURACY

. . . that cuts machining and fabricating time, reduces scrap-loss; speeds production of hollow parts

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TYPES	**Seamless (hot finished and cold drawn). Welded (from hot or cold rolled strip).**
GRADES	**Carbon, Alloy, and Stainless.**
SIZES	**Up to 8⅝" O.D. in full range of wall thicknesses.**
QUALITY	**Open-hearth, and electric furnace steels, including aircraft and magnaflux qualities.**
CONDITION	**Unannealed, annealed, tempered, normalized, or otherwise heat-treated as required.**
SURFACE FINISHES	**As rolled, as drawn, as welded, bead removed, turned, scale-free, and polished.**

B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY

GENERAL OFFICES: BEAVER FALLS, PA. PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO

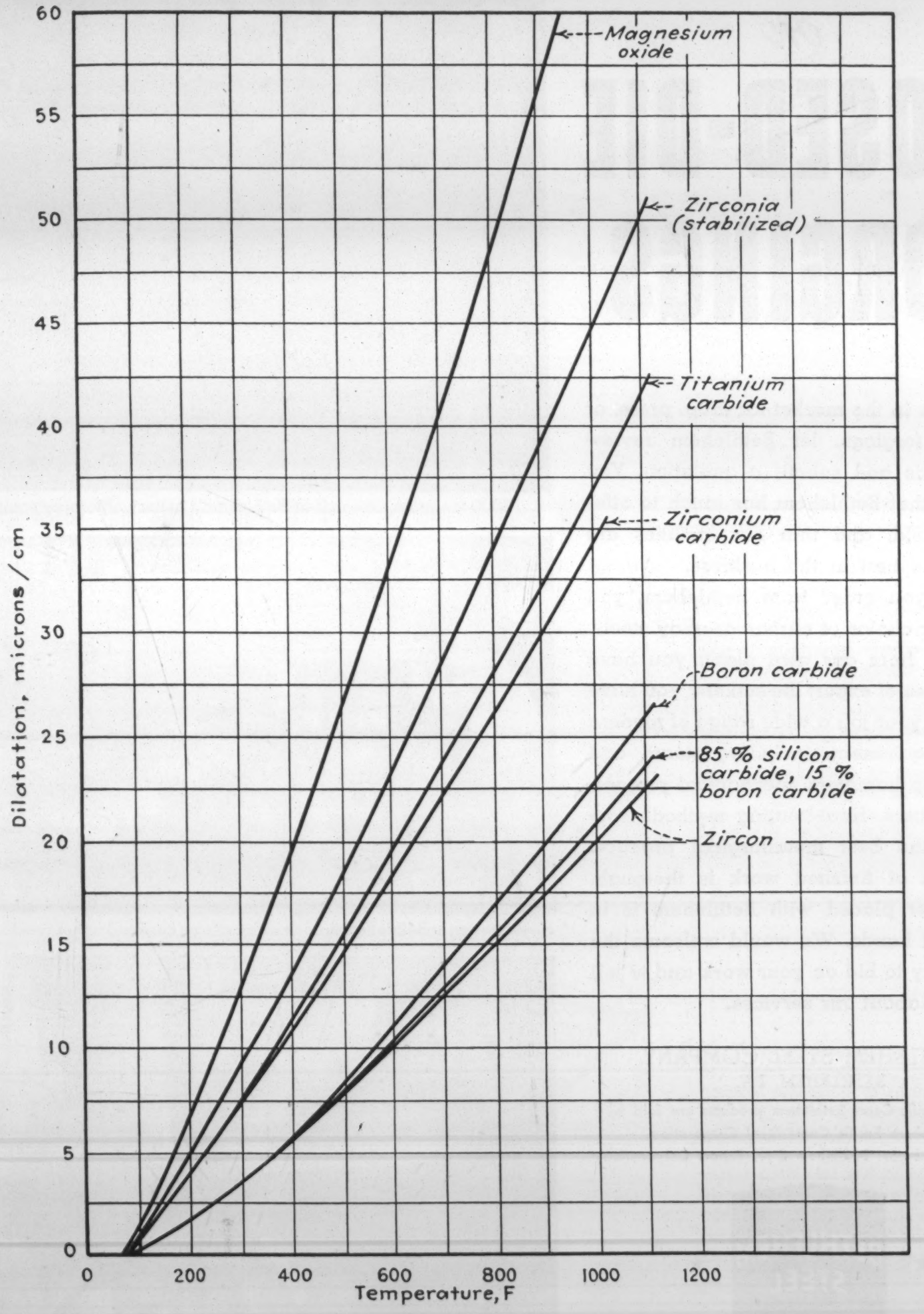
TA 1304-A

Materials Engineering File Facts

NUMBER 183
November, 1949

MATERIALS: Ceramics

Thermal Expansion Properties of Typical Hot-Pressed Ceramics



Data taken from "Physical Properties at Elevated Temperature of Seven Hot-Pressed Ceramics", by Gangler, Robards & McNutt, National Advisory Committee for Aeronautics.

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on

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If you are in the market for drop, press, or upsetter forgings, let Bethlehem review your needs and submit a quotation. You will find that Bethlehem has much to offer in this field, and that our facilities are among the best in the business.

When you order from Bethlehem, you have your choice of carbon or alloy steels, available from our own plant; you have the services of expert die-sinkers; you have ready for your job a wide range of modern forging equipment, including steam and board drop hammers, mechanical presses, and upsetters. Heat-treating methods conform to the best metallurgical practice. Inspection of finished work is thorough.

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BETHLEHEM, PA.

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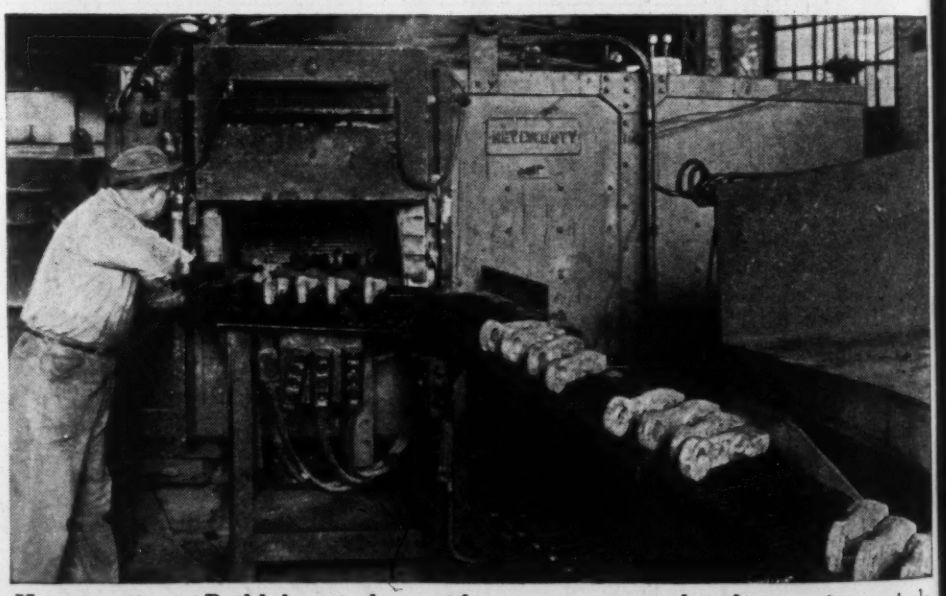
Export Distributor: Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

2000-ton press, one unit in Bethlehem's battery of forging equipment.



Heat-treating at Bethlehem is done with extreme care and under precise controls.

Shot-blasting an order of drop forgings prior to inspection.

New Materials and Equipment

MATERIALS

Iron & Steel 82, 92, 100, 110, 120
Nonferrous Metals 80, 92
Plastics 88, 102, 104, 110
Other Nonmetallics 80, 104, 114, 124
Parts & Forms 80, 82, 100
Coatings & Finishes 88, 96, 124

EQUIPMENT

Heat Treating & Heating 79, 98, 100, 104
Cleaning & Finishing 80
Welding & Joining
82, 84, 86, 88, 106, 112, 120, 122
Forging & Forming 79, 90, 92
Machining 114, 120
Melting, Casting & Molding 94, 98, 100, 112, 122
Inspection & Control 82, 88, 90, 124

High-Speed Tool Steels Bright Hardened in Unconventional Unit

A uniquely constructed furnace for bright hardening high-speed tool steels has been developed by *Lindberg Engineering Co.*, 2444 W. Hubbard St., Chicago 12.

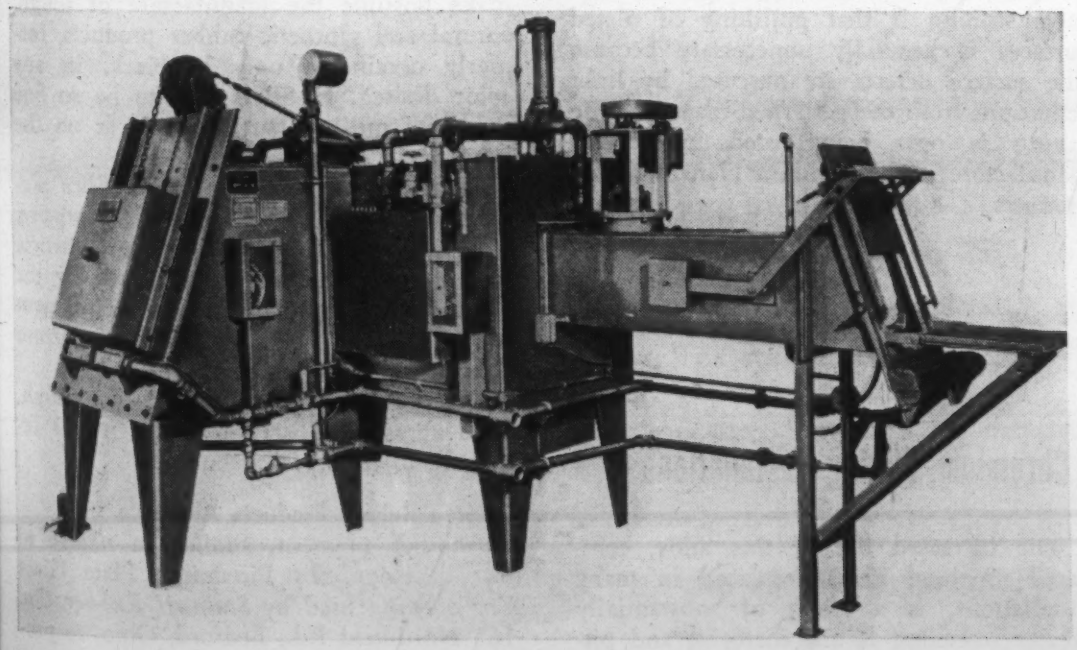
The new unit is claimed to harden molybdenum, 18:4:1, 18:4:2, or cobalt type steels totally free from carburization or decarburization. It is designed primarily for cutters, thread chasers, etc., that have fine cutting edges and cannot be ground or cleaned after hardening.

The furnace contains preheat, high heat and quench sections; the preheat is built at right angles to the high heat section. Quenching is by means of forced convection in a cooled protective atmosphere; sections of high-speed steel up to 2 in. can be fully hardened by the atmosphere quench.

Among the disadvantages of conventional installations corrected by this combination unit are: scaling of work when it is removed from the preheat into air and transferred to high heat; contamination of high heat atmosphere when charging door is opened; scaling and slight decarburization of the steel when it is removed from the furnace through air to the quench.

The protective atmosphere used is supplied by a separate atmosphere generator. An endothermic atmosphere generated from city, natural, propane or butane gases, or a charcoal-generated atmosphere can be used.

In order to extend this protection to the tempering operation, the company has provided retorts (supplied with the same protective atmosphere used in hardening) to be used in its standard air tempering furnaces.



This Lindberg furnace combines preheat, high heat and quench sections for bright hardening high-speed tool steels.

● *Taber Instrument Corp.*, 109 Goundry St., North Tonawanda, N. Y., has announced production of an improved model, No. 123, of its Thermocreaser, designed to make right angle folds on sheet plastic materials used in making rectangular transparent containers and other types of packages. Folds of less than 90° can also be made by a simple adjustment of the temperature of the folding blade, or by altering the shape of the groove in the folding die.

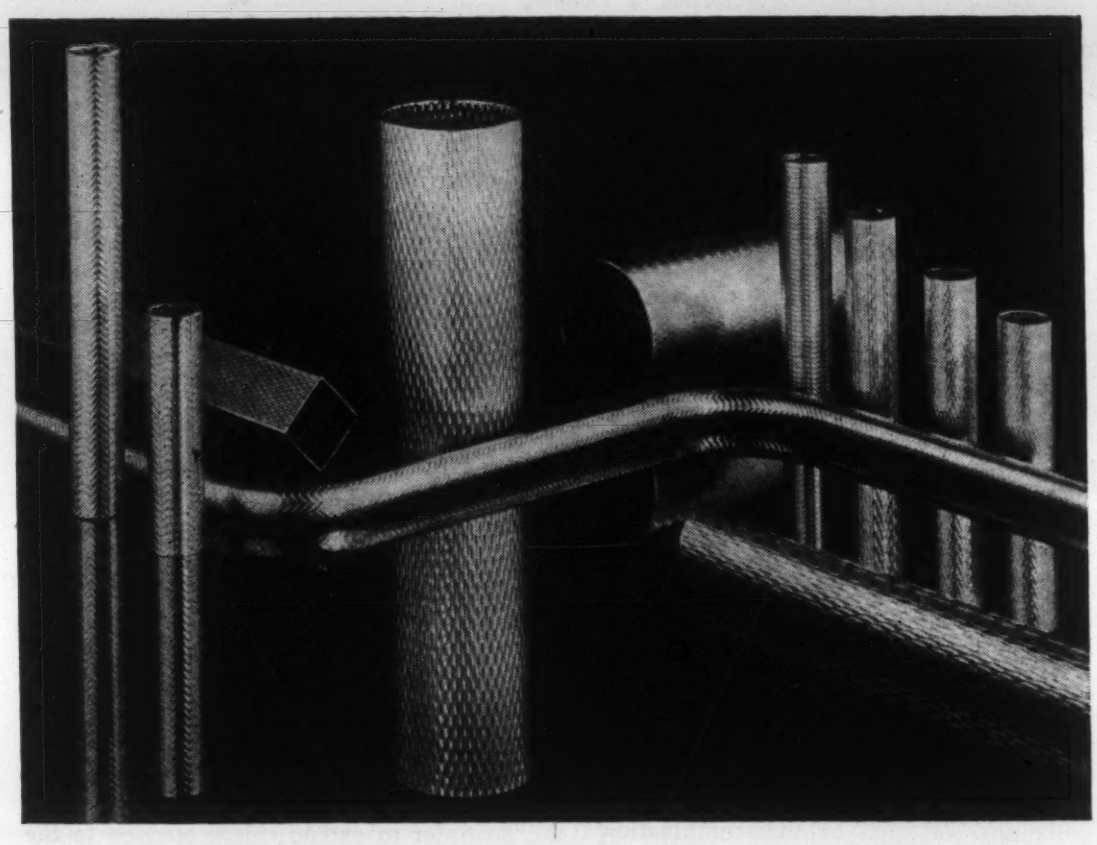
New Materials and Equipment
(CONTINUED)

Rigidized Welded Steel Tubing Has Strength, Attractiveness

Rigidized welded tubing of carbon, stainless, and low-alloy high-tensile steels is being produced by *Standard Tube Co.*, Detroit, under an exclusive agreement with *Rigidized Metals Corp.*, Buffalo, N. Y.

Rigidizing is a patented process for roll-forming textured patterns in flat metal which redistributes the metal through the cross section, thus increasing stiffness, strength and impact value and, at the same time, producing attractive surfaces. In the production of Rigidized tubing, the patterns are rolled into the strip, subsequently formed and electric-resistance-welded into tubing. Because patterns are rolled on both sides of the strip with a male and female roll, 16 gage is the heaviest strip currently rolled.

An additional advantage of Rigidized metal tubing is that polishing of plated surfaces is generally unnecessary because fine surface defects are obscured by light reflections from the patterned material. The tubing is now being used by several manufacturers of chromium plated tubular products.



Rigidized welded tubing is now being manufactured by Standard Tube Co.

New Lead Alloy Has Longer Life in Chromium Plating Installations

A new lead alloy, named Nalco Metal, has been developed by *National Lead Co.*, 111 Broadway, New York 6, for longer service in chromium plating installations. Composition of the new alloy has not been disclosed.

The increased life of this alloy, compared to those it has replaced in many installations, is a result of substantially greater resistance to the corrosive and pitting action of chromic acid solutions. Corrosion tests conducted by National Lead Co. under certain typical conditions have shown an 11-day corrosion loss of only 1% for Nalco Metal compared to 50% for the 6% antimonial lead formerly used in chromium plating.

The alloy is used for tank linings, anodes and heating-and-cooling coils. Use of Nalco Metal is said to eliminate the need for anodic treatments to re-establish lead chromate protective coatings on linings and coils.

In sheet form, the new alloy is claimed to be as easily cut, trimmed and shaped to tank contours as the alloys previously used. In pipe form, the metal can be readily coiled or looped and bound, clipped or blocked into units of any desired design or form.

Nickel- or Chromium-Finished Round Edge Flat Wire Available

Round edge flat wire, furnished in nickel or chromium finish on steel base, is now available from *American Nickeloid Co.*, Peru, Ill. The smooth, rigid wire can be supplied finished on one or both sides.

Available sizes range from 0.035 to 0.125 in. in thickness and 3/16 to 2 in. in width. Standard length in nickel finish is 71 in. or 142 in. cut into two parts, neither part exceeding 95 in. In chromium finish, lengths are 70 in. or 140 in. cut into two parts, neither part exceeding 94 in.

Rubber Colored, Toughened by Extremely Fine Silica Pigment

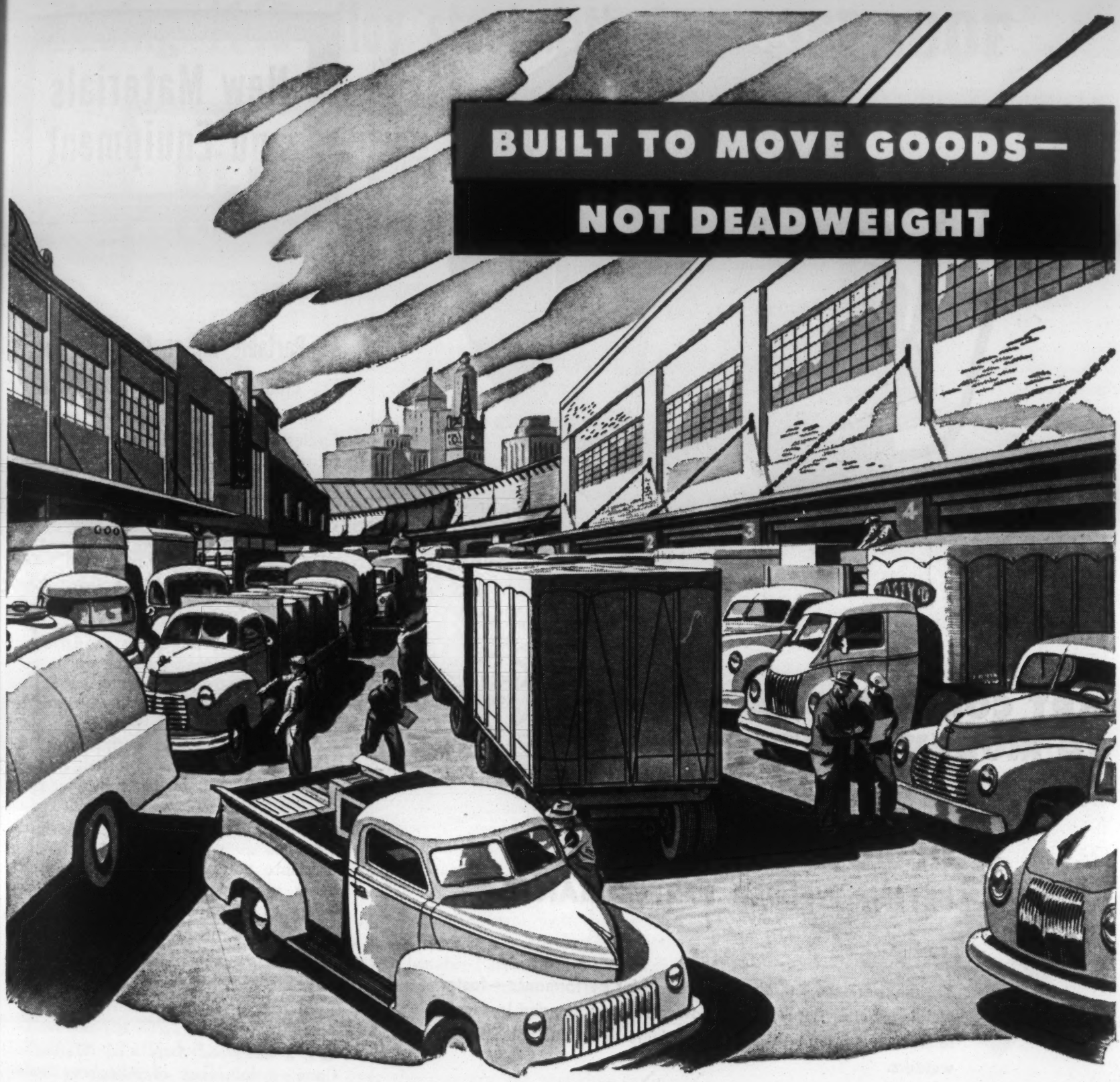
Development of an extremely fine silica pigment by the *Columbia Chemical Div.* of *Pittsburgh Plate Glass Co.*, 632 Duquesne Way, Pittsburgh 22, is claimed to make possible the manufacture of tough, natural and synthetic rubber products, formerly obtainable only in black, in any color desired. Hi-Sil is said to be so fine that 300 million particles will fit on the head of an ordinary pin.

Described as the first practical silica pigment in its field, Hi-Sil is very absorptive. It has a specific gravity of 1.95 and particle size of 0.025 micron as measured by the electron microscope. The pH of the pigment can be varied over a wide range, from about 2.5 to 9.5.

The pigment imparts high tensile strength, good abrasion resistance and high tear resistance to rubber compounds.

Colored Rubber Products Available

Another pigment, similar in nature to that developed by Pittsburgh Plate Glass Co. is being used by *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio, to produce rubber products in any color or tone specified.



The weight's in the load and not in the truck when frames, body panels, fenders, wheels and other truck structural parts are made of N-A-X HIGH-TENSILE. And while affording weight savings of up to 25% in section, the high physical properties of N-A-X HIGH-TENSILE insure superior strength and increased resistance to fatigue, corrosion, abrasion and denting.

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MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
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APT COMPANIONS TO MUREX ELECTRODES-

ENGINEERED TO GIVE YOU BETTER WELDER PERFORMANCE

You'll experience entirely new arc welder performance—faster welding, better quality welds, lower power costs, and less maintenance—with the new, up-to-the-minute M & T AC and DC arc welders.

AC units feature *Built-in Capacitors* for low operating cost... *Fingertip, Stepless Current Control* for precise welding current... *Wide Current Range* plus *Ample Overtravel* for full rated output with long electrode leads. Furnished in 200 to 500 amp models for manual work; others for inert arc and automatic welding.

DC units are *Compact and Lightweight*... half as big and half as heavy as older types... yet are built for full capacity, rugged industrial duty... and are equipped with *Automatic Current Selector*. Available in 150 to 400 amp models—motor-driven, engine-driven, belt-drive.

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New Materials and Equipment

Portable Meter Designed for Electrolysis, Corrosion Work

M. C. Miller, 1142 Emerson Ave., West Englewood, N. J., has announced availability of a new, small model of the Multi-Combination Meter designed specifically for electrolysis and corrosion investigations and cathodic protection testing in both field and laboratory. Model B is intended for use where the high accuracy of the No. 5 meter is not required, and where a lighter weight, more compact and rugged portable meter is desired.

The new instrument is available with either of two sets of instruments. In Model B-1, the low-resistance voltmeter is 1000 ohms per volt and the high resistance voltmeter is 20,000 ohms per volt. In Model B-2, the low-resistance voltmeter is 3000 ohms per volt and the high resistance voltmeter is 62,500 ohms per volt. Nine ranges from 10 m.v. to 100 v. are provided on the low resistance voltmeter. Six ranges from 0.1 v. to 20 v. are provided on the high resistance voltmeter. A milliammeter/ammeter is provided with nine ranges from 2 m.a. to 20 amp.

● *Wallingford Steel Co.,* Wallingford, Conn., a subsidiary of *Allegheny Ludlum Steel Corp.,* has announced production of 18:8 bright annealed stainless strip steel in widths up to 15 in. This is claimed to be the widest stainless steel strip ever manufactured and is expected to implement fabrication of many items previously unobtainable with this steel.

Recent Developments in Welding Equipment, Controls Announced

Three-Phase Control Improves Weld

A new three-phase, low-frequency control for resistance welding has been announced by *Westinghouse Electric Corp.,* P. O. Box 868, Pittsburgh, Pa. The control is designed to enable a welding transformer to draw power from a three-phase line, convert it to lower frequency single-phase, and supply this to the electrodes of a resistance welder.

Replacing 4140 alloy steel with STRESSPROOF

REDUCED the COST of this shaft 25%

THIS splined drive shaft was originally made from 4140 hot-rolled, normalized, and machine-straightened alloy steel. After cutting to length, the bar was quenched and tempered to a machinable hardness and restraightened. By changing to STRESSPROOF, these quenching, tempering, and straightening operations were eliminated, steel cost was reduced, machining time was cut 33%, and the quality of the part was improved. Over-all reductions in cost afforded a net saving of 25%.

Cost-conscious manufacturers all over the country are realizing savings such as this, and higher . . . because of STRESSPROOF's unique combination of four important qualities *in-the-bar*. STRESSPROOF is twice as strong as ordinary cold-finished shafting and does not require heat treating. Its wearability—*without case-hardening*—is sufficient to replace many heat-treated or carburized steels. In addition, it machines fully 50% better than heat-treated alloys of the same hardness, and, being stress-relieved, it has a minimum of distortion. Yet, with all these advantages, STRESSPROOF costs little more than ordinary cold-finished shafting. It is available in cold-drawn or ground and polished finish.

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City_____ State_____

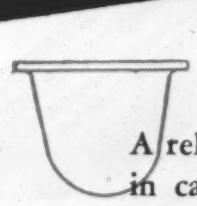
***Manufacturer of the Most Complete Line of Carbon and Alloy Cold-Finished and Ground and Polished Bars in America**

Meehanite®

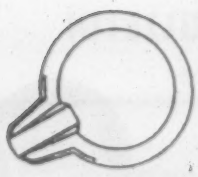
MELTING POTS

by

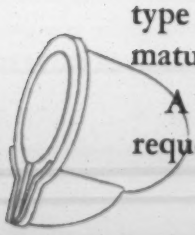
Brake Shoe



A reliable and economical source of melting pots is found in castings by Brake Shoe of Meehanite metal. *Reliable* because of Brake Shoe's wide metallurgical knowledge and thorough foundry techniques that protect structural soundness and physical properties. *Economical* because of the longer life expectancy of a sound casting closely matched to its service.



In melting pots, Brake Shoe uses a type of heat-resisting Meehanite chosen to withstand constant heating, intermittent heating and cooling, flame impingement and contact with molten metals. Whether you require the type used for melting aluminum or that for melting lead or zinc, pouring type or holding type, count on these castings to resist premature cracking, warpage, growth, oxidation and corrosion.



A list of available sizes and prices will be sent you on request.

7320

AMERICAN Brake Shoe COMPANY

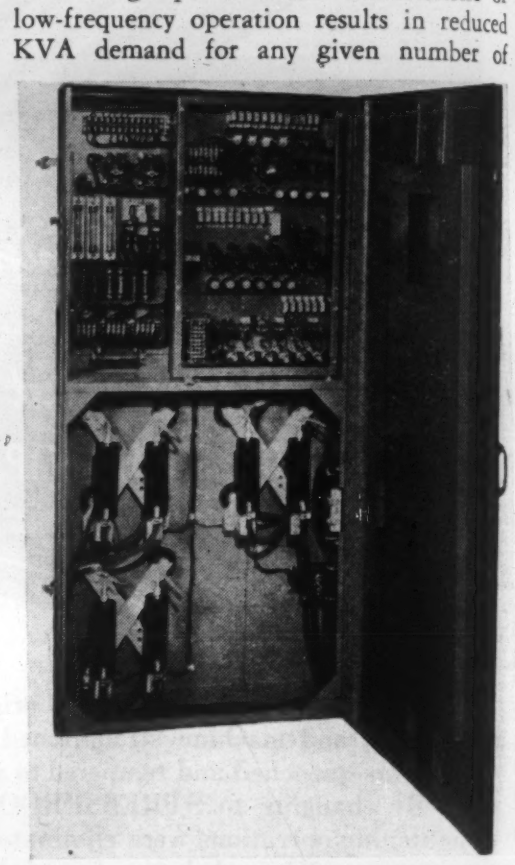
BRAKE SHOE AND CASTINGS DIVISION

230 PARK AVENUE, NEW YORK 17, N. Y.

New Materials and Equipment

An increase in weld quality is claimed as the result of better wave shapes obtained with three-phase control. The three-phase wave favors a smooth flow of heat into the metal.

The high power factor characteristic of low-frequency operation results in reduced KVA demand for any given number of



This new Westinghouse welding control can be mounted on the floor or on the side of the machine.

amperes at the electrodes. The total power demand is spread over all phases of any standard three-phase, 60-cycle, 220-, 440- or 550-volt primary power source.

A complete packaged unit that controls all mechanical and electrical functions of the welding machine is available. It can be mounted on the floor or on the side of the machine. A swing-out panel provides easy access to all components and circuits.

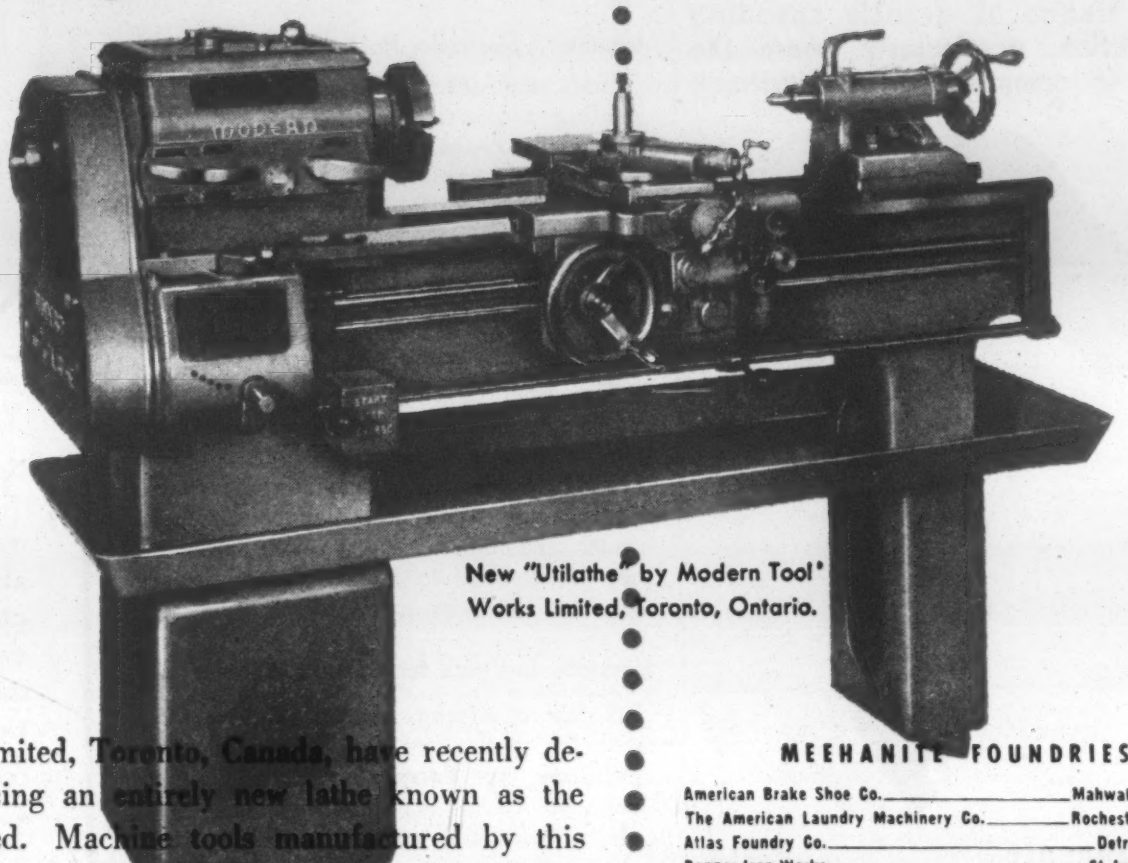
Portable Spot Welder Handles ⅛-In. Steel

A portable spot welder which will weld stainless and mild steel up to ⅛-in. combined thickness is being manufactured by *National Cylinder Gas Co.*

The Sureweld model weighs only 23¼ lb. It operates on 220-v. a.c. lines (25 amp.), single phase, 50/60 cycle. Alternate tongs are available with tips set at 90° or 45° angle, as well as telescopic style which allows maximum reach into hard-to-get-at places.

Designed for intermittent duty, the portable spot welder is adapted for use in garages, auto repair shops and on the farm

Machine Tool Precision Requires MEEHANITE® *Properties and Quality*



New "Utilathe" by Modern Tool Works Limited, Toronto, Ontario.

THE Modern Tools Works Limited, Toronto, Canada, have recently designed and are now producing an entirely new lathe known as the MODERN "Utilathe", illustrated. Machine tools manufactured by this company have acquired a reputation for precision accuracy and maximum performance in production.

From its inception this machine was designed to take full advantage of those engineering properties of Meehanite castings which would contribute to its quality, such as good strength characteristics, maximum vibration absorption, dimensional stability, uniform solidity and good machinability. These castings include:

1. Bed
2. Carriage
3. Cross Slide
4. Compound Slide
5. Headstock
6. Tailstock

Designers of this equipment, like those of many other machine tools "design with confidence" based on their sure knowledge that Meehanite castings over the years provide, regularly and repeatedly, known and established engineering characteristics. Builders of today's equipment rightfully demand this assurance of dependability.

Your product—your new design, can benefit similarly.

For further information write for the Handbook of Meehanite Metals to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

Meehanite® NEW ROCHELLE, N. Y.

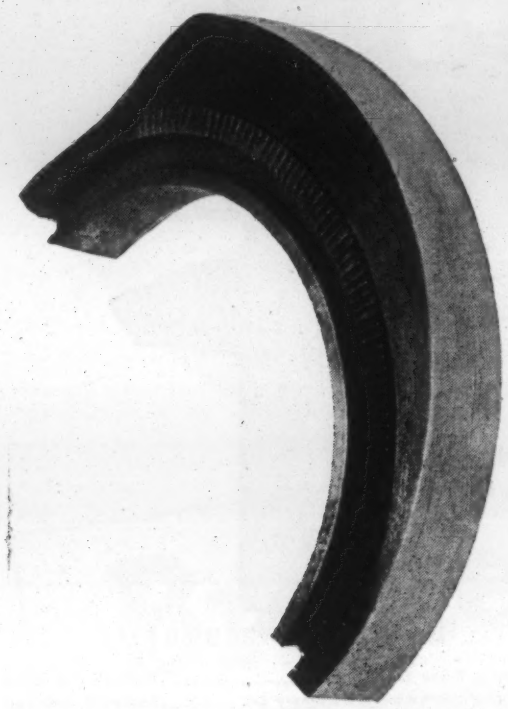
Carburit

PACK HARDENING PASTE

hardens desired sections only

.030 INCHES IN 30 MINUTES

Carburit offers the easiest, quickest method for hardening work when some sections must be left soft. It is a means of greatly speeding production, particularly where the work is complicated and critical.



Here CARBURIT was used to case-harden only the outer surface. Depth of case—.040". Hardness after quenching 65 Rockwell C.

1. Easiest method for section hardening—apply paste only to parts of work that require case-hardening.
2. No special equipment needed. For the first time pack-hardening is possible even where no furnace is available.
3. Not poisonous or toxic.

Order a sample quantity today

Test CARBURIT . . . Use the coupon

DENFIS

CHEMICAL LABORATORIES, INC

172 Pacific St. • Brooklyn 2, N. Y.

Gentlemen: Please send complete information regarding Carburit Pack-Hardening Paste.

Name .....

Title .....

Firm .....

Address .....

.....

New Materials and Equipment

as well as in shipyards, factories and sheet metal shops.

Insulator, Electrode Holder Announced

Two new developments in the field of welding accessories have been announced by *Jackson Products*, Warren, Mich.

One of these products is an insulated arc welding electrode holder of the blade type. Known as Model BT-3, it will take ¼-in. electrodes at 300 amp. It consists of a minimum of easy-to-replace parts and is claimed to be economical, safe and cool-working.

The other development is an improved crown-type jaw insulator now available on this company's entire line of arc welding electrode holders. The insulators are made of laminated fibreglass with melamine binder and other heat resistant material; they are claimed to be five times stronger than the insulators originally furnished.

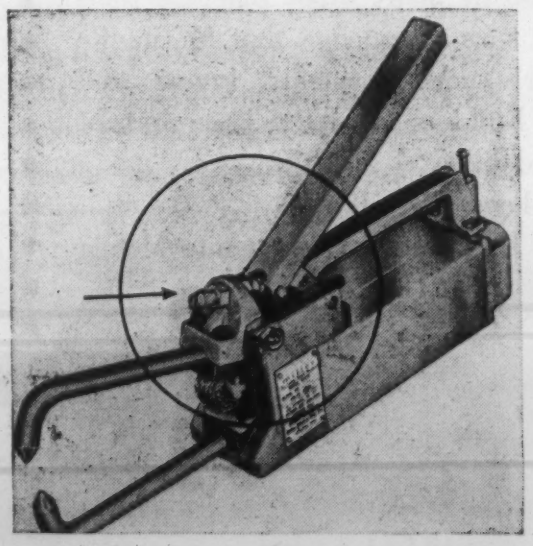
Electrode Designed for Uphand Welding

A fast-solidifying general purpose electrode for steel sheet and plates has been developed by *Eutectic Welding Alloys Corp.*, 40 Worth St., New York 13, especially for uphand welding and "poor fit" joints.

The high burnoff rate of this electrode, known as Eutectrode 6000, is said to make possible use of high currents with resulting increases in welding speeds. The electrode has a hardness of 200 Bhn. and tensile strength of 64,000 to 72,000 psi. It is available in sizes 3/32, ⅛, 5/32 and 3/16 in.

Toggle-Action Lever Used on Spot Welder

An improved portable spot welder with a new toggle-action tong lever has been announced by *Miller Electric Manufactur-*



Easier operation is claimed for this Miller spot welder featuring a patented toggle-action tong lever.

here's what they say about

CrysCoat

for preparing metal surfaces for painting, there is nothing to equal the OAKITE CrysCoat* PROCESS!

YES, painting and finishing superintendents and foremen, process and product engineers, job paint shop-owners, chemists and metallurgists everywhere, are saying good things about the OAKITE CrysCoat PROCESS. They have found that it:

- **cleans metal surfaces and conditions them for painting**
- **improves the adhesion of paint to metal**
- **prevents corrosion before metal is painted**
- **localizes corrosion under paint if finish is scratched or damaged**

and does all these things with minimum equipment . . . in minimum time . . . at minimum cost

FREE Write to Oakite Products, Inc., 32H Thames St., New York 6, N. Y., for illustrated folder F7642 which describes the OAKITE CrysCoat PROCESS and tells how it *cuts cost 10 ways* in preparing metal for painting.

*Reg. U. S. Pat. Off.

OAKITE

Trade Mark Reg. U. S. Pat. Off.

SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

PRODUCT DESIGN STUDIES • NO. 23

FABRICATED FLANGE

CAST STEEL FLANGE

Failures Eliminated Weight Reduced 18% Savings with STEEL CASTINGS

As originally produced, this cable winch flange collapsed on numerous occasions, requiring replacement.

Faced with the problem of finding a way to eliminate these failures—a serious matter in the oil field where this equipment is used — the manufacturer turned to steel castings.

By eliminating the principal cause of failure—lack of rigidity—and by providing high resistance to fatigue and vibration, steel castings gave the degree of dependability required, with a reduction in weight from 1,400 to 1,150 pounds.

Although cost of the part was about the same, manufacturer saved time and money by eliminating storage and maintenance of jigs, fixtures, and templates necessary for fabrication of the part as a weldment.

* * *

Conversion of some of *your* highly stressed parts to steel castings may result in equal if not greater benefits than those given here.

Also in new and redesigned parts, your steel foundry engineer may be able to suggest ways to cut costs and weight and obtain other substantial benefits . . . if you call him in for a discussion *while your product is still on the drawing board.*

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by Steel Founders' Society of America.

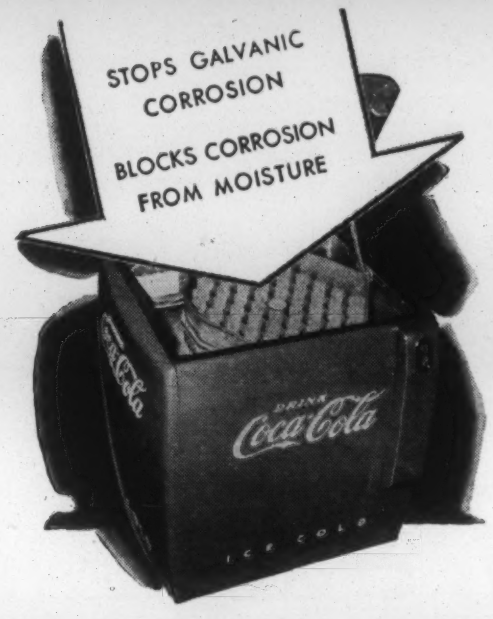
STEEL FOUNDERS' SOCIETY OF AMERICA

220 Midland Building • Cleveland 15, Ohio

IRIDITE

gives galvanized parts

2-way RUST PROTECTION



A clean, sanitary appearance and freedom from corrosion are "musts" inside this beverage cooler manufactured by The Vendo Company, Kansas City, Missouri. That's why Iridite was chosen to finish hardware parts and the galvanized vending basket. Iridite stops galvanic corrosion because it forms protective barrier between dissimilar metals. Iridite blocks corrosion from moisture because it seals the metal from contact with condensed moisture.

3 WAYS TO USE IRIDITE

Iridite offers you a complete line of finishes for any zinc or cadmium surface . . . plated, die cast or galvanized, and for any finishing problem . . . corrosion resistance, paint base or eye appeal.

SIMPLE TO OPERATE

You'll find Iridite easy to use, too. It requires no special equipment or personnel, goes on with a short, non-electrolytic dip, dries fast and gives uniformly good results from manual or automatic application.

If you use zinc or cadmium in any form, you can use Iridite. Write today for data and samples, or, send specimens of your product for FREE IRIDITE PROCESSING. *Special note:* Ask about Iridite Bright for zinc or cadmium-plated parts. See how you can get durability and chrome-like brightness at amazing low cost.

ALLIED RESEARCH PRODUCTS, INC.
4004 EAST MONUMENT STREET
BALTIMORE 5, MD.

West Coast Licensee—
L. H. Butcher Co., Los Angeles 23, California

New Materials and Equipment

ing Co., Appleton, Wis. The toggle-action unit, which has been patented by the company, is said to make possible greatly increased tong pressure, resulting in better spots and easy operation.

The toggle-action lever is designed to eliminate difficulties found in ordinary lever-type spot welders in exerting sufficient hand pressure to pull together material where fit-up is poor. The lever can be adjusted to either close tight on the work or to pivot past center and lock tight on the work. In this way the operator can close the welder on the material to be spotted, forcing it up tight and locking together, then operate the switch with his other hand. An adjustment is provided between the lever and the tongs to compensate for various thicknesses of metal.

● A new model Thermo Electric Pyrometer, built to indicate temperatures at from one to six thermocouple locations at operating ranges from 75 to 400, 1000, 1600 and 2300 F and from —300 to 300 F, has been announced by *Thermo Electric Co., Inc.,* Fair Lawn, N. J.

New Bonding, Filling Agents Feature Ease of Application

Two new products for bonding of similar and dissimilar materials and correcting porosity in metal parts have been introduced by *Western Sealent, Inc.,* 9042 Culver Blvd., Culver City, Calif. Principal advantage of bonding Agent R-313 and Flawmaster as compared to earlier products of this company is said to be easy manual application without the need of intricate machinery.

Bonding Agent R-313 bonds glass, plastics, neoprene, leather goods, etc., to metals, and ferrous to nonferrous metals, etc. It is claimed to have high resistance to pressure, heat and chemicals.

Flawmaster is a thermosetting compound used to reclaim metal parts and castings otherwise rejected for surface flaws, sand pitting, foundry gas holes, faulty machine surfaces, taps, etc.; it matches the metal to which it is applied. The material is machinable, chemically inert, and heat resistant in a wide range of temperatures.

Free Folder!

- - tells how to finish ZINC OR CADMIUM for better CORROSION RESISTANCE ...PAINT BASE

Eye Appeal

If your product uses zinc or cadmium in any form, find out now about Iridite . . . the chemical dip finishes that boost corrosion resistance . . . provide a paint base that defies peeling, flaking, chipping . . . brighten zinc, keeps it bright and free from stains. Write for details today . . . or better still, send samples of your product for FREE processing.

IRIDITE COATINGS *are used on - -*

Washing Machine Parts • Radio Equipment
Kitchen Utensils • Aircraft Parts
Lock Hardware • Office Machines
Window Frames • Vending Machines
Wire Cloth • Tools
Lamp Fixtures • Fuel Pumps
Carburetors • Auto Hardware
Zinc Coated Sheet • Hinges, Screws, Bolts
Camera Parts • Plumbing Fixtures
Wall Panels • Refrigerator Parts
Wire Products • Instrument Parts
Electrical Equipment

ALLIED RESEARCH PRODUCTS, INC.
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HOW WOULD YOU LIKE YOUR TUBING?

Rare...Medium...Well Done?

(Direct from the Welder) **(Partially Processed)** **(Fully Fabricated)**

The ELECTRUNITE menu is a varied one, including a wide selection of sizes, shapes, analyses, gages, physical properties and surface finishes. From it, you're sure to find the *one* tubing which best meets *all* of your application requirements.

DIRECT FROM THE WELDER TUBING . . . Produced to *your* requirements from either hot or cold rolled steel by Republic's improved electric resistance welding process. Delivered to you uniformly strong, clean and sound.

PARTIALLY PROCESSED TUBING . . . whether you require a special length, precision diameter or higher than standard physical properties . . . or a combination of these . . . ELECTRUNITE always comes to you as you like it.

FULLY FABRICATED TUBING . . . or, if your product requires a bent, swaged, flared, expanded or tapered part . . . or a completed assembly . . . Steel and Tubes' modern facilities and experienced personnel are prepared to handle the job for you.

See your nearest Steel and Tubes Representative or write *today* for more information.

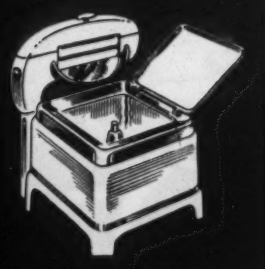
REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Building, New York 17, New York

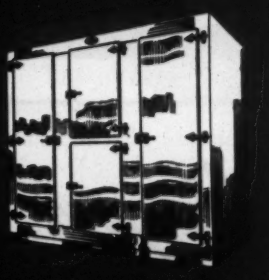
Republic
REPUBLIC STEEL REG U S PAT OFF
ELECTRUNITE TUBING

HOW TO MAKE GOOD PRODUCTS BETTER
AT NO EXTRA COST...

with PERMACLAD
STAINLESS CLAD STEEL

Truly corrosion resistant!
Easily formed or deep drawn!





The Finer
The Finish The
Finer The Product
For The Finest Finish
Use
PERMACLAD

PERMACLAD
STAINLESS CLAD STEEL

A Product of ALAN WOOD STEEL COMPANY

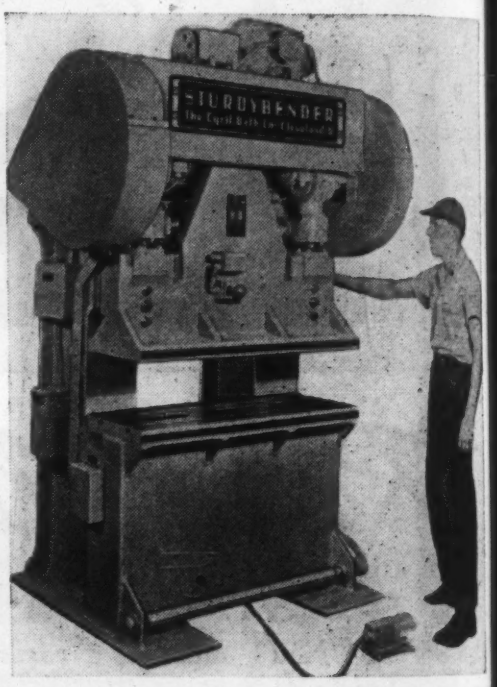
OTHER PRODUCTS:

New Materials and Equipment

Line of Press Brakes Features Speed, Wide Bed and Ram Areas

A line of press brakes having wide bed and ram areas and capable of speeds up to 80 strokes per min. has been announced by *Cyril Bath Co.*, 6901 Machinery Ave., Cleveland 3, Ohio.

The new high-speed press is equipped with a safety mechanism which can be used in continuous operation or operated to stop automatically at the top of the stroke. In addition, accidental excessive



Shown here is a 35-ton press brake, one of the new Cyril Bath line. It has a die area of 15 by 42 in.

loads automatically throw out the clutch, preventing damage to press or dies.

The flexible ram setting, low die cost and operator convenience typical of the press brake are claimed for this machine. These high-speed presses are designed as production tools, combining the adaptability of the press brake with the long slides and air clutches characteristic of the conventional press.

● The *Industrial Controller Div.* of *Square D Co.*, Milwaukee 12, Wis., has announced production of a new size OW, 50-amp. welder contactor designed for small spot welding machines up to 10 KVA at 220 v. or 20 KVA at 440 v. High rupturing capacity and longer magnet life are claimed for this controller.

FLAME-RESISTANT

LIGHTWEIGHT

ECONOMICAL

VERSATILE

COLORFUL

TOUGH

Housing is molded in two nesting parts. Pin-point gating reduces finishing operations, yields sturdy pieces free from flow marks. Motor, circulating fan and scent-block assembly are held in place by a metal bracket mounted by means of four metal bushings press-fitted into the plastic housing.

(DISTRIBUTED BY Y & Y DEODORIZER CO., PHILADELPHIA, PA.)

Another Design *First*

attained with "Hercules" Flame-Resistant Acetate

First device of its type to be molded with "Hercules" Flame-Resistant Acetate, the IRO Electric Deodorizer also becomes the the first commercially available model to obtain Underwriters' Laboratories approval.

"Hercules" Flame-Resistant Acetate gives the housing of this unique deodorizer its impact strength, its attractive ivory color, as well as the all-important advantage of a truly self-extinguishing material which can be rapidly injection molded.

Housings and similar applications utilizing "Hercules" Flame-Resistant Acetate are bringing added sales appeal to a growing list of electrical appliances. Our technical staff invites inquiries on improving *your* product with a quality Hercules material.

CELLULOSE ACETATE

"HERCULES" IS REG. U. S. PAT. OFF.

HERCULES POWDER COMPANY

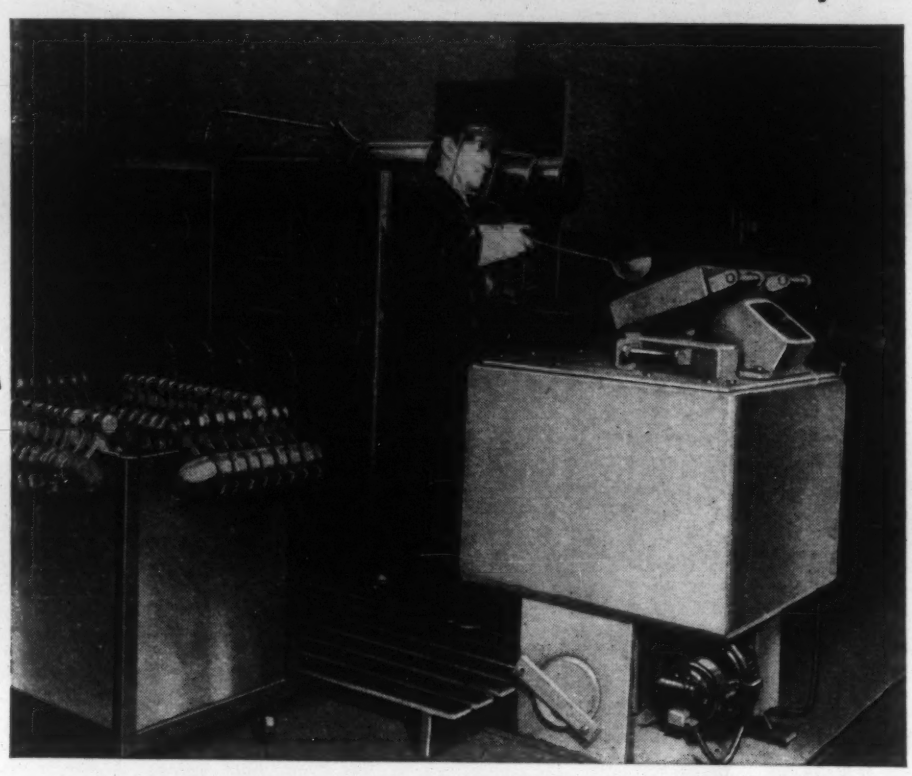
INCORPORATED

996 Market Street, Wilmington 99, Delaware

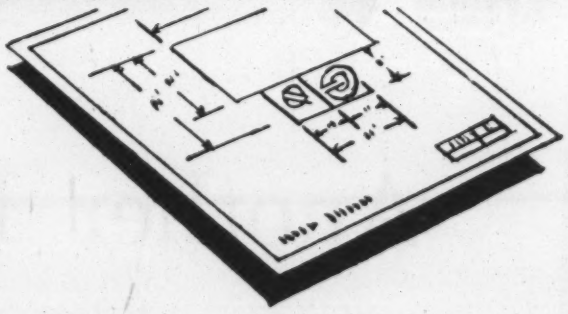
CP9-8

★TOP PERFORMANCE WITH AJAX TAMA-WYATT

INDUCTION FURNACES for Aluminum Alloys



Ajax Induction Holding Furnace at Mid-Western Die Casting Co., Chicago, Illinois.



★ BETTER PRODUCTION THROUGH TOP PERFORMANCE IS THE AJAX RECORD

Ajax-Tama-Wyatt induction furnaces are used in the United States and abroad for melting and holding aluminum alloys in die casting, permanent mold, and sand foundries.

No flux or mechanical stirring is necessary. The metal is in constant gentle circulation assuring complete blending of alloys, and a uniform temperature throughout the metal.

Electric energy costs less than fuel and avoids danger of overheating. Completely automatic temperature controls hold metal to within 5°F., at the lowest possible temperature for perfect casting. With an Ajax the yield for perfect castings is exceptionally high.

There are no fumes and operation is practically noiseless. Shops are cooler, more comfortable — manpower efficiency is increased. Shop space is increased, for an Ajax Holding Furnace takes an average of 30 to 40 percent less floor space than any other furnace.

The Ajax companies have been pioneers in induction melting of metals since the first World War. To date they have installed more than 400,000 KW. of furnace capacity in the United States alone. This is the background of experience behind every Ajax installation.

AJAX ENGINEERING CORPORATION • Trenton 7, New Jersey

AJAX TAMA-WYATT — **INDUCTION MELTING FURNACE**

Associate Companies: **AJAX METAL COMPANY**, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

New Materials and Equipment

Magnesium-Ferrosilicon Alloy Aids Nodular Graphite Formation

Formation of nodular graphite in cast iron is promoted by a new magnesium-ferrosilicon alloy available from the *Electro Metallurgical Div.* of *Union Carbide & Carbon Corp.* The alloy contains about 7 to 10% magnesium, 43% silicon and the balance is mainly iron. It is available in the standard size of ⅜ in. and smaller.

The hazards of a magnesium addition are said to be minimized when this magnesium-ferrosilicon alloy is used to produce nodular iron. Only one ladle addition is required, as the alloy acts both as a nodulizing and an inoculating agent.

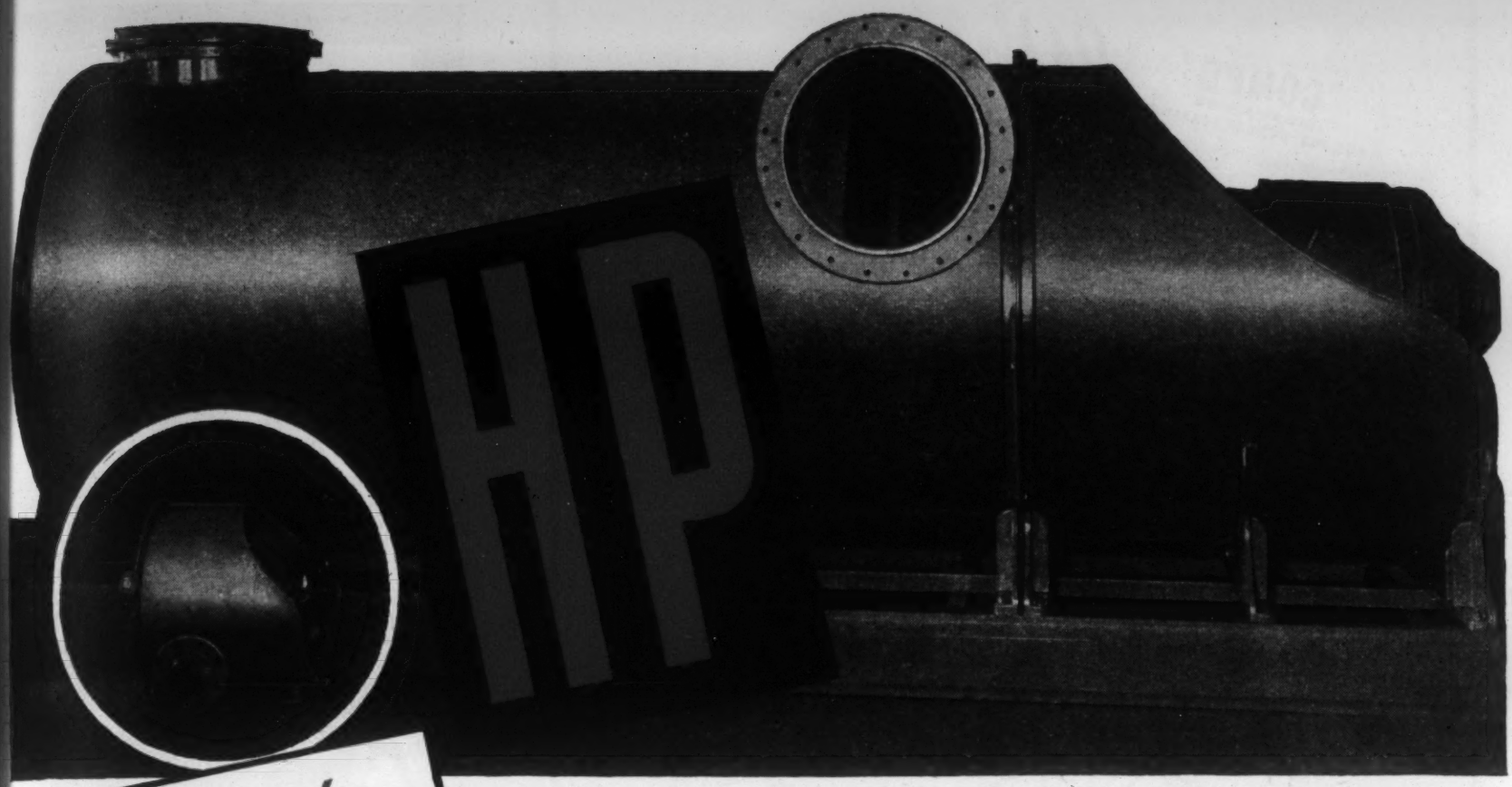
● A compound spreader, which automatically applies drawing compounds to sheet metal, is being produced by *Union Tool Corp.*, Warsaw, Ind. Models are available to fit any size stock up to 96 in. wide.

Crank, Hydraulic Press Design Changed to Meet New Standards

New lines of straight side single and double crank presses, and single and double action hydraulic presses have been developed by *E. W. Bliss Co.*, 1420 Hastings St., Toledo 7, Ohio, in conformance with recently established standards of the Joint Industry Conference.

For the single and double crank presses, these standards provide slightly larger tonnage and weight capacities and bend and slide areas than former standards. Important features of the new presses are: "box" type crowns and slides reinforced by deep internal ribs; barrel type slide permitting long adjustment to accommodate dies varying greatly in height; four-piece Meehanite tie rod construction of all press frames; longer slides and gibs for precision grinding of die work; power adjustment of slide; and pneumatic friction clutches mounted on the crankshaft of single end drive presses up to 250 tons.

A 650-ton single action press, first of the new hydraulic line to be produced, is claimed to provide lower initial cost, lower maintenance cost, smoother and quieter operation, and increased production. Design changes on this press include: simplified circuit and use of dual flow pumping



1/3 800

ASK FOR THESE BULLETINS

TECHNICAL BULLETIN No. 126
DATA BOOK No. 107
GAS BOOSTERS No. 109
FOUR BEARING No. 110
BLAST GATES No. 122
FOUNDRIES No. 112

You may not need an 800 HP Turbo-Compressor but it is interesting to know that this Spencer machine is delivering large volumes of air at 10 lbs. pressure for engine testing.

The midget Spencer delivers 85 cubic feet per minute at 8 ounces pressure and is used by the hundreds by manufacturers of heat treating, air conditioning and pneumatic tube systems as a part of their finished products.

The Spencer Turbo is distinguished by its simple, sturdy construction, with constant pressure automatically delivered with high efficiencies at all loads.

Quiet operation without vibration is one of the advantages of the Spencer Turbo. This is due to several factors: the multi-stage construction resulting in low peripheral speeds; lightweight perfectly balanced impellers with wide clearances; and a ball bearing supported by a cast bridge work.

SPENCER TURBO APPLICATIONS

AGITATION • HEAT TREATING • GAS BOOSTERS • VENTILATION

Standard sizes from 35 to 20,000 cu. ft.; 1/3 to 800 HP ; 8 oz. to 10 lbs. Single or multi-stage, two or four bearing. Special gas-tight and non-corrosive construction available. Ask for the Turbo Data Book and Bulletins.

359-C

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONN.

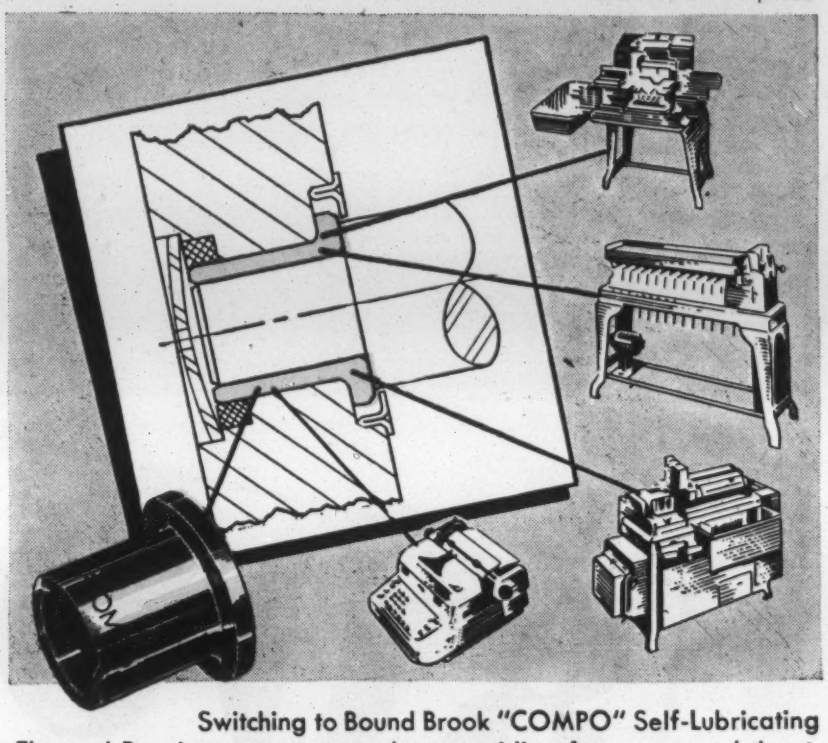
SPENCER HARTFORD

TURBO-COMPRESSORS

"COMPO" OIL-RETAINING POROUS BRONZE BEARINGS

Why Nationally-Known Business Machine Manufacturers* Use "COMPO" SELF-LUBRICATING BEARINGS

*Names on request



Switching to Bound Brook "COMPO" Self-Lubricating Flanged Bearings meant more than providing for severe end thrust. It meant:

To the manufacturers:

- *Simplification of design, quicker, lower cost assembly and elimination of costly machining operations.*

To end users:

- *No periodic lubrication, maintenance costs cut, and continuous, quiet, trouble-free operation.*

"COMPO" Porous Bronze Bearings are made from pure metal powders, die-formed to shape, alloyed at high temperatures, finished to exact dimensions, and vacuum-impregnated with lubricant. Self-lubricating qualities make them ideal for use in inaccessible spots. The lubricant is sealed in, free from dirt, and an even lubricating film is always present.

Thousands of "COMPO" Bearing sizes can be made from existing dies; hundreds of sizes in stock for prompt shipment. Use coupon below, to get our free Stock List or arrange a conference with one of our engineers. *We've saved time and costs for others, we can do the same for you.*

Many other types of "COMPO" Bearings and "COMPO" structural parts have been designed into business machines, appliances and other types of equipment at equal savings and with equal performance benefits.

BOUND BROOK OIL-LESS BEARING COMPANY

BEARINGS • BUSHINGS **WASHERS • PARTS**

BOUND BROOK, N. J. **ESTABLISHED 1883**

Bound Brook Oil-Less Bearing Co.
Bound Brook, N. J.

MM 11-48

☐ I would like to talk to one of your engineers about_____

☐ Please send me a copy of your "COMPO" Bearing Stock List.

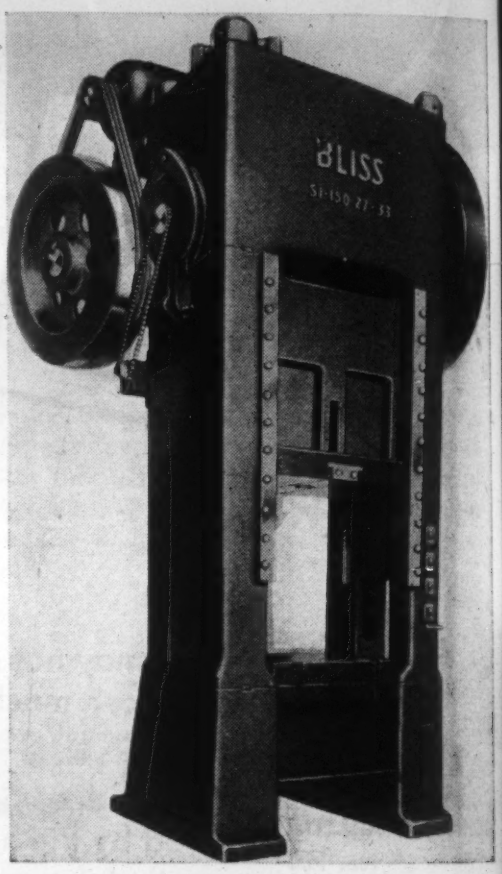
Name_____ Title_____

Company_____

Street_____ City_____ State_____

New Materials and Equipment

system; major reduction in amount of piping and valves; unit design of frame, cylinder and slide; prestressed tie rod frame; four adjustable flat type Meehanite gibs with removable wear strips on uprights; foot valve directly connected to cylinder; no interconnecting piping; open type prefill valve; and pump design which permits reversing of oil flow and provides controlled



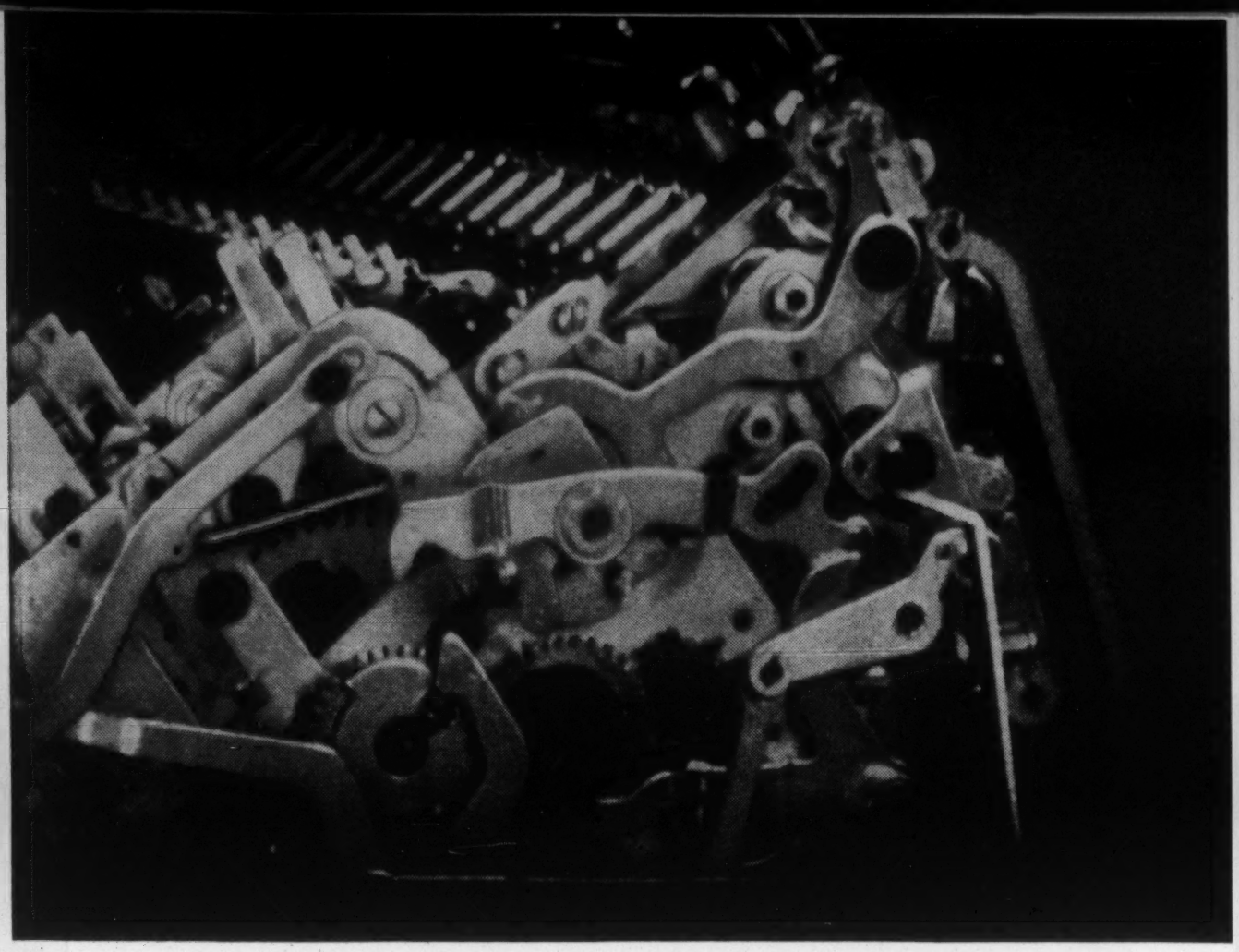
This 150-ton press is the first of the new design Bliss straight side single and double crank line.

gravity descent with smooth starting and stopping as well as smooth release of pressure at end of stroke.

The Bliss presses are used in metal working for blanking, cutting, punching, shaping, stamping and embossing. Equipped with Bliss Marquette Die Cushions, they can be employed for a considerable range of drawing and forming work.

Reverberatory Tilting Furnaces Have Wide Range of Capacities

Reverberatory tilting furnaces of the Sklenar type for the melting of ferrous and nonferrous metals are now available from *Bellevue Industrial Furnace Co.*, 2971 Bellevue Ave., Detroit. The self-contained units range in capacity from 350 to 20,000 lb.,



Frames of movie film, taken with Kodak High Speed Camera, show a desk-type calculating machine performing automatically at five hundred r.p.m.

Now high speed movies with good depth of field

TODAY high speed movies provide the research scientist with more detailed information than ever. For with the Kodak High Speed Camera, these pictures are sharp and clear and in addition have remarkably good depth of field.

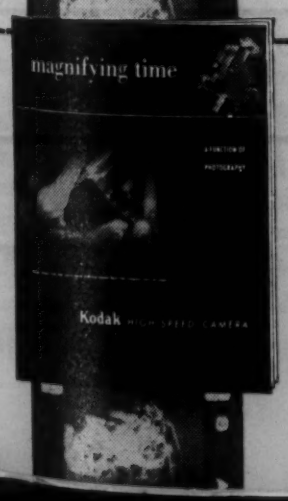
This is due both to the high intensity lighting now available and to the high-quality optical system which employs a rotating, accurately plane-parallel glass plate behind the lens to sweep the image in synchronism with the traveling film.

In the example illustrated, the camera was operating at 2000 frames per second with a lens aperture of *f*/8. Illumination of 7 to 15 times the intensity of sunlight on a bright day was provided by the new General Electric 750R Reflector Photographic Lamp.*

If you would like more information about the Kodak High Speed Camera, just mail the coupon. Eastman Kodak Co., Rochester 4, N. Y.

*This lamp may be ordered from your local Kodak dealer.

the Kodak *High Speed* Camera



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EASTMAN KODAK COMPANY, Rochester 4, N. Y.
Gentlemen:
Please send me: ☐ your folder "Magnifying Time" which describes the High Speed Camera; ☐ a 16mm. sample reel of high speed motion study which I may borrow.

Name_____ Firm_____

Address_____

City_____ State_____

Kodak
TRADE-MARK

Cut Polishing Time Improve Surface Quality

with "LINDE" FINE ALUMINA POWDERS

Now, you can choose the type of finish you want, free from microscopic pits and scratches, on metallic and non-metallic surfaces. And you can get these superior results in a fraction of the usual polishing time by using ultra-fine LINDE abrasive powders.

Because of extremely uniform particle size and form, smaller amounts of LINDE Fine Alumina Powders go further. You can use them directly from the container without expensive preparatory steps—or compound them with waxes and other vehicles to suit your need.

Two types are available. Type A is a quick-acting powder of hexagonal structure and sapphire hardness. Type B produces a still finer polish, almost as quickly.

LINDE Fine Alumina Powders may be the answer to your polishing problems. They have already gained acceptance in polishing metallographic specimens, gemstones, and other materials. Call or write any LINDE office to find out how these powders can be used to advantage in your particular polishing applications.

The term "Linde" is a trade-mark of The Linde Air Products Company

	Type A	Type B
Chemical Composition	Alpha Al_2O_3	Gamma Al_2O_3
Particle Size (approximate)	0.3 Micron	Less than 0.1 Micron
Hardness (Mohs) (Equivalent to crystalline material)	9	8
Crystalline Structure	Hexagonal	Cubic

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

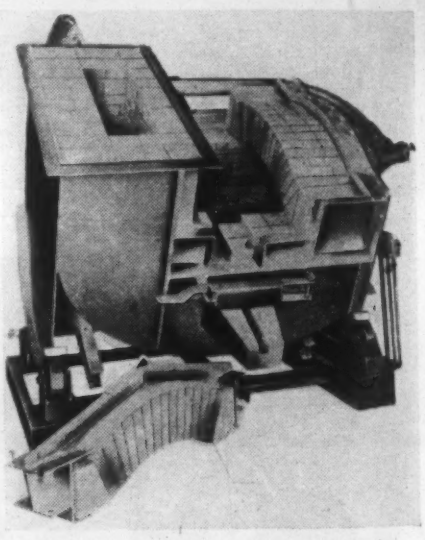
New Materials and Equipment

and can produce 13 to 21 melts per day.

Sklenar type melting furnaces are readily accessible for skimming, refining, alloying and inspection during the entire melt. The type of tilting mechanism is governed by the size of furnace; hydraulic or compressed air automatic tilt is available for furnaces with capacities over 1000 lb. of brass, whereas furnaces of less capacity are hand tilted.

The metal is charged through a hopper which also serves as outlet for exhaust from the combustion chamber. The preheated metal is melted in the hopper; it then trickles down into the metal bed. Continuous charging can be maintained using borings, spillage or almost any other form of metal, as well as ingot metal.

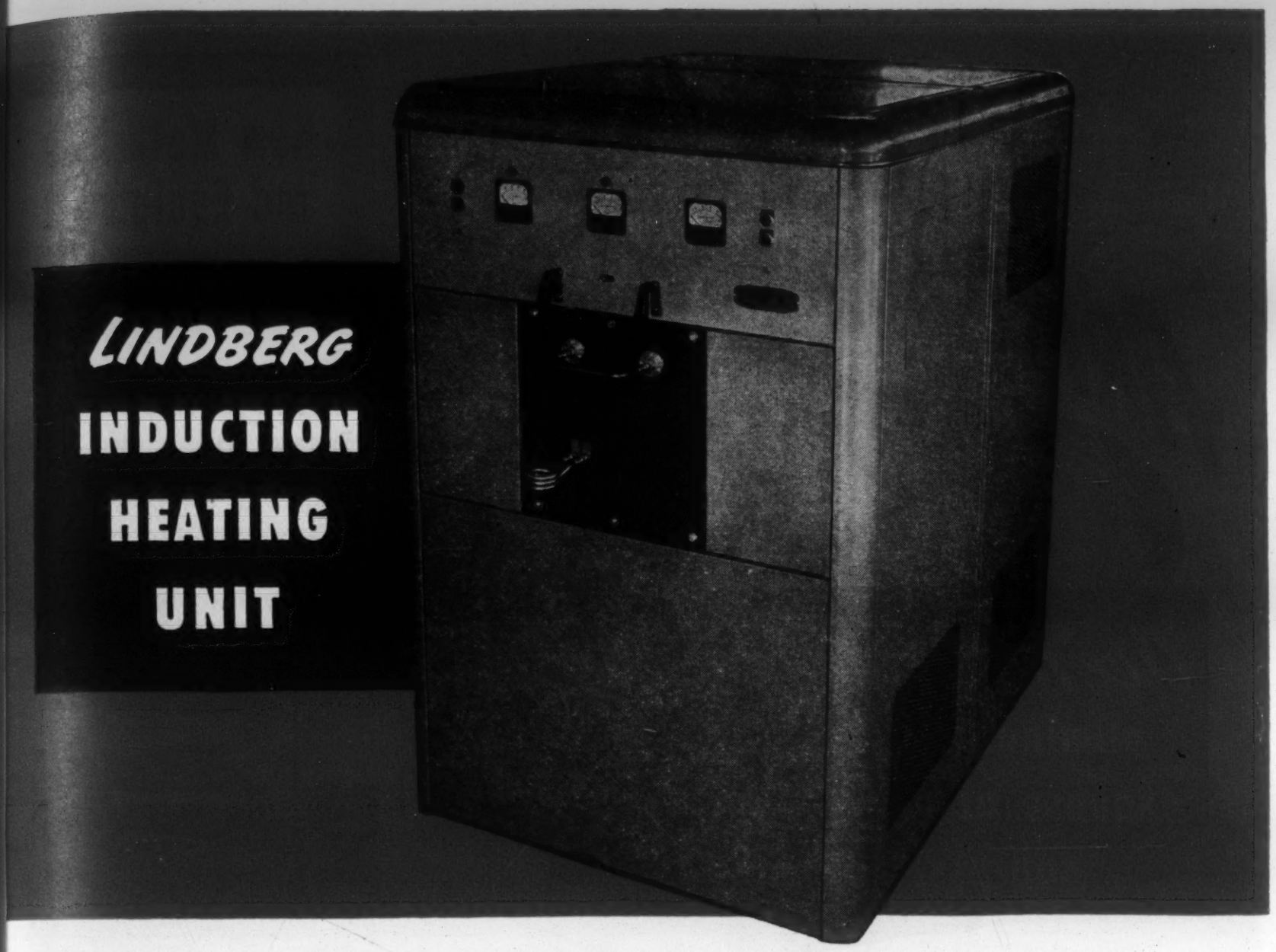
Fast melting and fuel economy are



Shown here is one of a new line of Sklenar-type melting furnaces manufactured by Bellevue Industrial Furnace Co.

achieved by using the same fuel to heat the combustion chamber that is used to melt the metal in the hopper. The unit is fired with oil or gas and draft is supplied by a blower, which is part of the furnace. Atmospheric conditions in the combustion chamber are closely controlled to eliminate occluded gases.

● *Bee Chemical Co.*, 13799 South Ave. "O", Chicago 33, has developed a new material which makes it possible to provide a white coating on a phenolic plastic surface with a single application and air drying. Identified as Phenolic White Coating R-1319, the product is claimed to be suitable wherever extremely high gloss is not needed and wear conditions are not too severe.



NEW and EXCLUSIVE developments in induction heating...

Available in single and two-station models the Lindberg LI-25 is ideal for hardening, brazing and soldering, annealing and stress relieving, hot forming and light forging, shrink fitting and other induction heating applications.

The Lindberg LI-25 is a ruggedly constructed vacuum-tube type unit for hard working production line jobs. Oscillator tube, power transformer and other major components deliver a full 25 KW with plenty of reserve to insure dependable day in and day out performance. Well designed—safe and simple to operate—featuring the most desirable developments in high frequency heating.

CONDITIONED COOLING—Built-in to increase tube life, eliminate harmful condensation and scaling, reduce water pressure and consumption—can be used with hard water. Rubber hoses are completely eliminated.

"CHECKLITE"—a unique feature exclusive with this unit, makes servicing easier, reduces maintenance costs.

AUTOMATIC CONTROL—when job cycles are set, automatic timer controls every phase of the operation—heat, quench, fixture movement.

SAFE AND SIMPLE—both operator and operating parts are protected—filament voltages are constantly regulated—tank capacitor is hermetically sealed—work coils protected against burn out. Every unit certified to meet FCC regulations. For detailed information write for Bulletin T-1420.

LINDBERG HIGH FREQUENCY HEATING

A DIVISION OF LINDBERG ENGINEERING CO.

2451 West Hubbard Street, Chicago 12, Illinois

YES, Ace hard rubber literally knocked the stuffings out of the arm for this chair. Formerly a padded, upholstered metal stamping bolted to the chair frame, it's now a one-piece, indestructible hard rubber molding, with leather-grain finish, and a feel that's just right.

What's more, it's assembled to the chair in a jiffy. You simply slide a headed insert into a slot, flex the rubber around the curve, and run up two screws from underneath.

You too may find "a better way" in one of the many Ace hard rubber or plastics molding and extruding compounds.

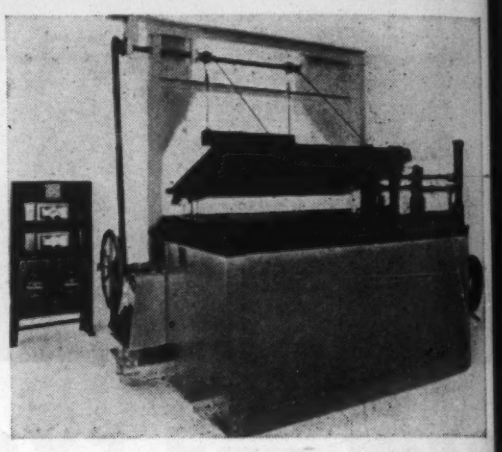
If you would like to know more about these Ace materials—where used—properties—design hints, etc., just write on your company letterhead for the new free 60-page Ace Handbook.

ACE AMERICAN HARD RUBBER COMPANY
Since 1851
HARD RUBBER and OTHER IMPORTANT PLASTICS
1 MERCER STREET • NEW YORK 13, N. Y.

New Materials and Equipment

Portable Gas-Fired Salt Bath Descales Stainless Steel Parts

A portable gas-fired salt bath for descaling processes on stainless steel parts is being manufactured by *James H. Knapp Co.*, 839 E. Fourth St., Los Angeles 13. It can be fired with natural, artificial or any of the low-pressure gases. The welded steel bath, which operates about 930 F, is heated



This Knapp salt bath can be operated on natural, artificial or any of the low-pressure gases.

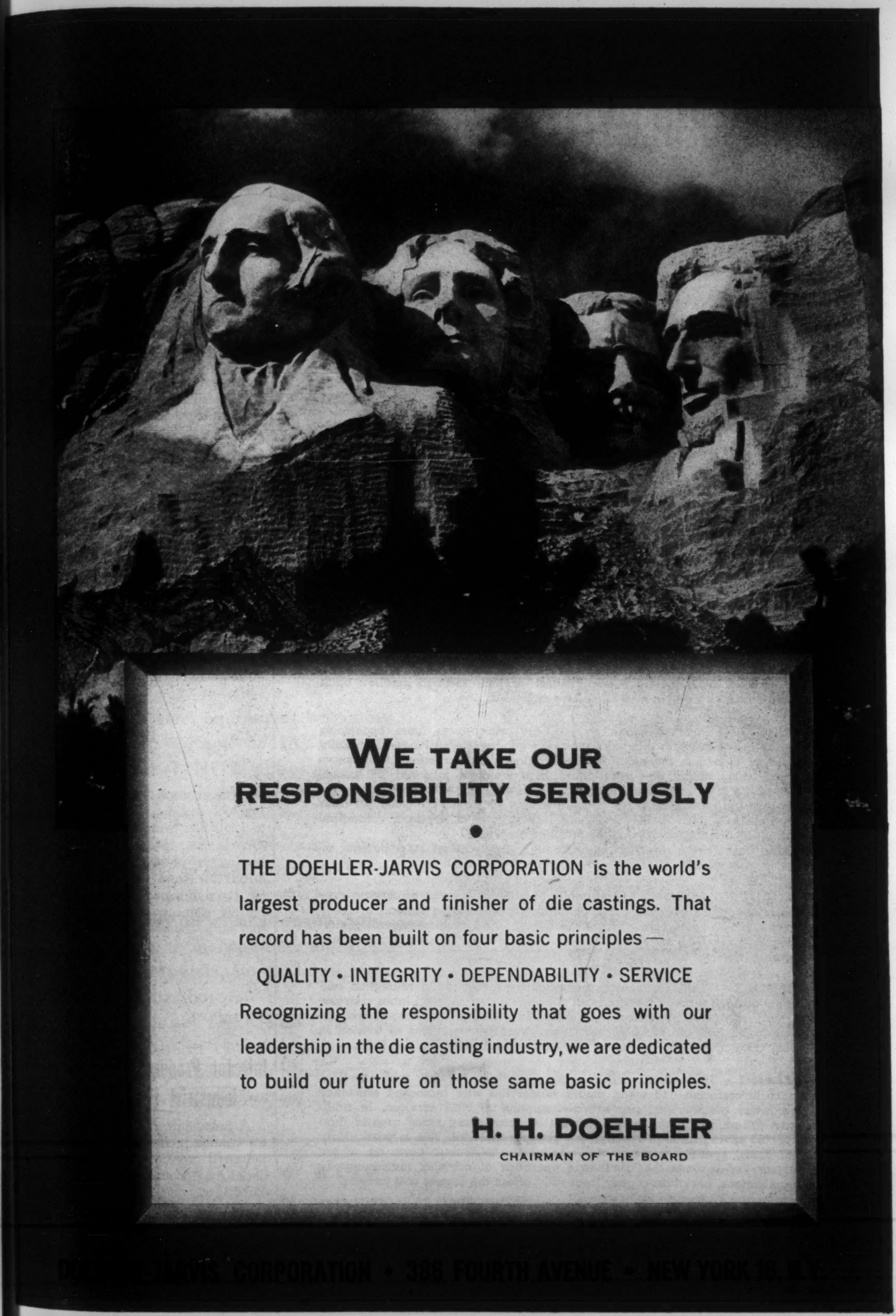
by two immersion tubes equipped with air-operated eductors to insure proper travel of gases.

The unit is encased in a heavy insulated steel shell. A motor-driven hinged lid covers the top and is arranged with limit switches and up-and-down push-button station; it can also be operated manually. All burners are electrically ignited and have flame failure cutouts. Heat is regulated by automatic temperature controls.

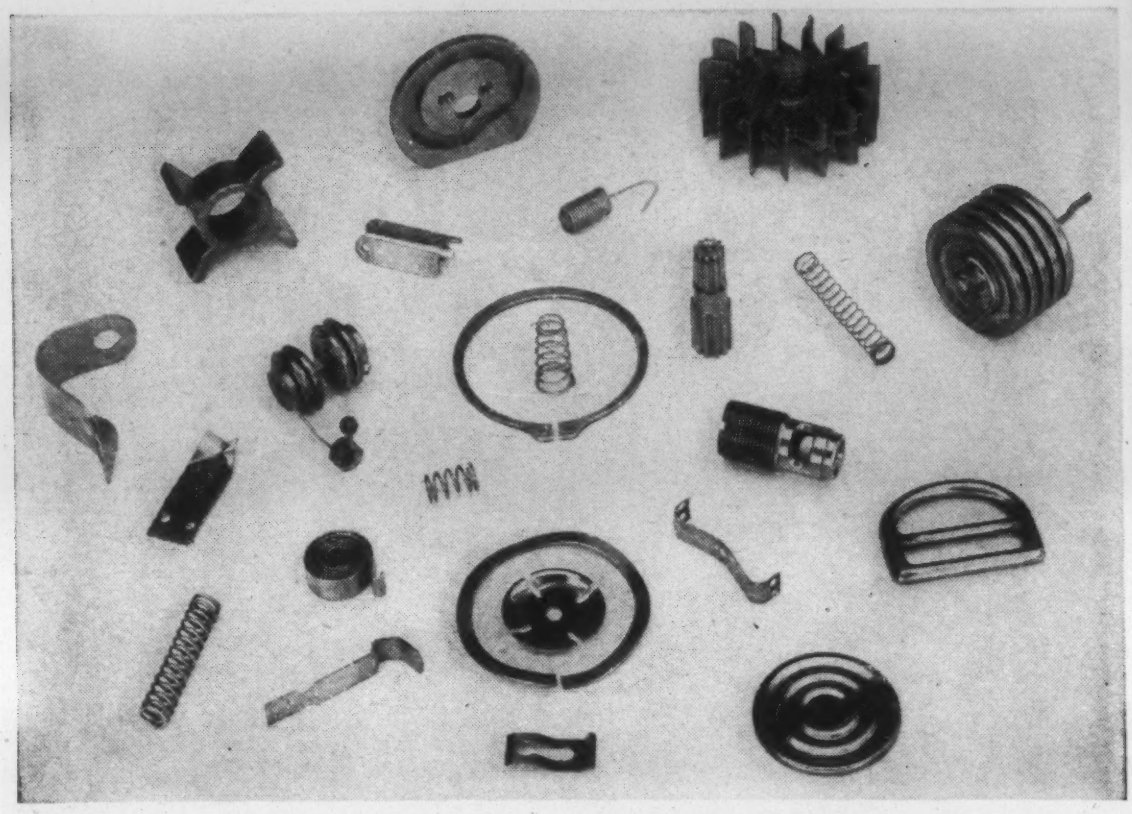
Zinc Alloy Die Castings Ejected More Easily with New Lubricant

Non-toxic Die Slick No. 9, a lubricant which prevents scoring and sticking of pressure die casting dies and enables easy ejection of castings from the die, is being manufactured by *G. W. Smith & Sons, Inc.*, 5400 Kemp Rd., Dayton 3, Ohio.

Applied with brush or spray, the lubricant does not stain and is claimed to assure a good surface finish on the casting. The compound leaves no carbon, gum or other residue in the die. The company recommends this lubricant especially for zinc alloy die castings that are to be plated, *e.g.* automotive hardware.


WE TAKE OUR
RESPONSIBILITY SERIOUSLY
•
THE DOEHLER-JARVIS CORPORATION is the world's largest producer and finisher of die castings. That record has been built on four basic principles —
QUALITY • INTEGRITY • DEPENDABILITY • SERVICE
Recognizing the responsibility that goes with our leadership in the die casting industry, we are dedicated to build our future on those same basic principles.
H. H. DOEHLER
CHAIRMAN OF THE BOARD

For **LOWEST COST** Where Performance Counts — Look to **BERYLLIUM-COPPER**



Dollar-conscious designers are saving money by considering the following factors which influence the over-all cost picture.

• **DESIGN** — Beryllium-copper's high strength makes possible smaller parts and lighter sections. This means important cost savings through smaller units, increased sensitivity and added flexibility of design.

• **FABRICATION** — Through heat-treatment beryllium-copper offers economies in fabricating severely formed parts requiring good strength. Parts are readily machined or formed in the unhardened condition, then hardened to maximum properties by a simple, low-temperature heat-treatment followed by uncontrolled cooling. For example, annealed BERYLCO 25S strip withstands the severest forming and reaches an ultimate tensile strength of 175,000 psi after heating for three hours at 600°F. Where less forming is required, cold-rolled tempers give correspondingly higher tensile values.
Also, absence of grain direction in moderately cold-worked strip permits efficient use of stock.

• **INSPECTION AND ASSEMBLY** — Uniformity of parts over large production runs reduces rejects and inspection costs, permitting spot checking instead of 100% inspection. Where necessary, fixture hardening insures dimensional control to a degree not otherwise obtainable and eliminates expensive hand adjustment during assembly.

• **MAINTENANCE** — Positive action as measured by resistance to relaxation and drift offers savings through less frequent calibration and reduced labor charges. These features are of particular significance in contacts, diaphragms and instrument springs. The stability of beryllium-copper prevents loss of tension in electrical contact springs, the cause of frequent adjustment in the field.

• **REPLACEMENT** — High elastic and endurance strength, together with excellent resistance to corrosion and wear, means longer life with increased efficiency through fewer breakdowns, preventing disruption of vital services. In addition, part failure may lead to replacement expense many times greater than the expected saving through specifying a cheaper material. This is particularly true for cams, springs, bushings and similar inconspicuous parts on whose faithful service depends the continuous operation of complex machinery. In such applications, beryllium-copper frequently offers the lowest cost answer.

Write today for literature, or if you have a design problem send us full information with a drawing or sample of the part.

BERYLCO BERYLLIUM

The **BERYLLIUM CORPORATION**

Dept. 5, Reading 3, Pa.

New Materials and Equipment

Permanent Magnet Materials Have High Induction, Coercive Force

General Electric Co., Pittsfield, Mass., has developed two new permanent magnet materials, Alnico 5 DG and Alnico 7.

Alnico 5 DG is a modification of Alnico 5 in which the crystal structure of the magnet is aligned in the direction of magnetization ("DG" refers to "directional grain"). As a result of this modification, smaller magnets can be used to do the same jobs larger magnets formerly did. This in turn makes possible a reduction in the size and weight of loud speaker magnetic frames and corresponding cost reductions. This new product is claimed to have the highest external and residual induction of any permanent magnet material known.

Alnico 7 has been developed specifically for applications where a high demagnetization force is present, as in motors, generators and variable air gap devices. This magnet has greater coercive force than any other grade of Alnico.

● An air draw muffle furnace for tempering tool and die steels at temperatures up to 1250 F is being produced by *Hevi-Duty Electric Co.*, Milwaukee, Wis. Uniform heating is promoted by a baffle which directs air from a high-speed centrifugal fan through a narrow passage between the heating elements and the baffle, then into the work chamber and back to the fan intake.

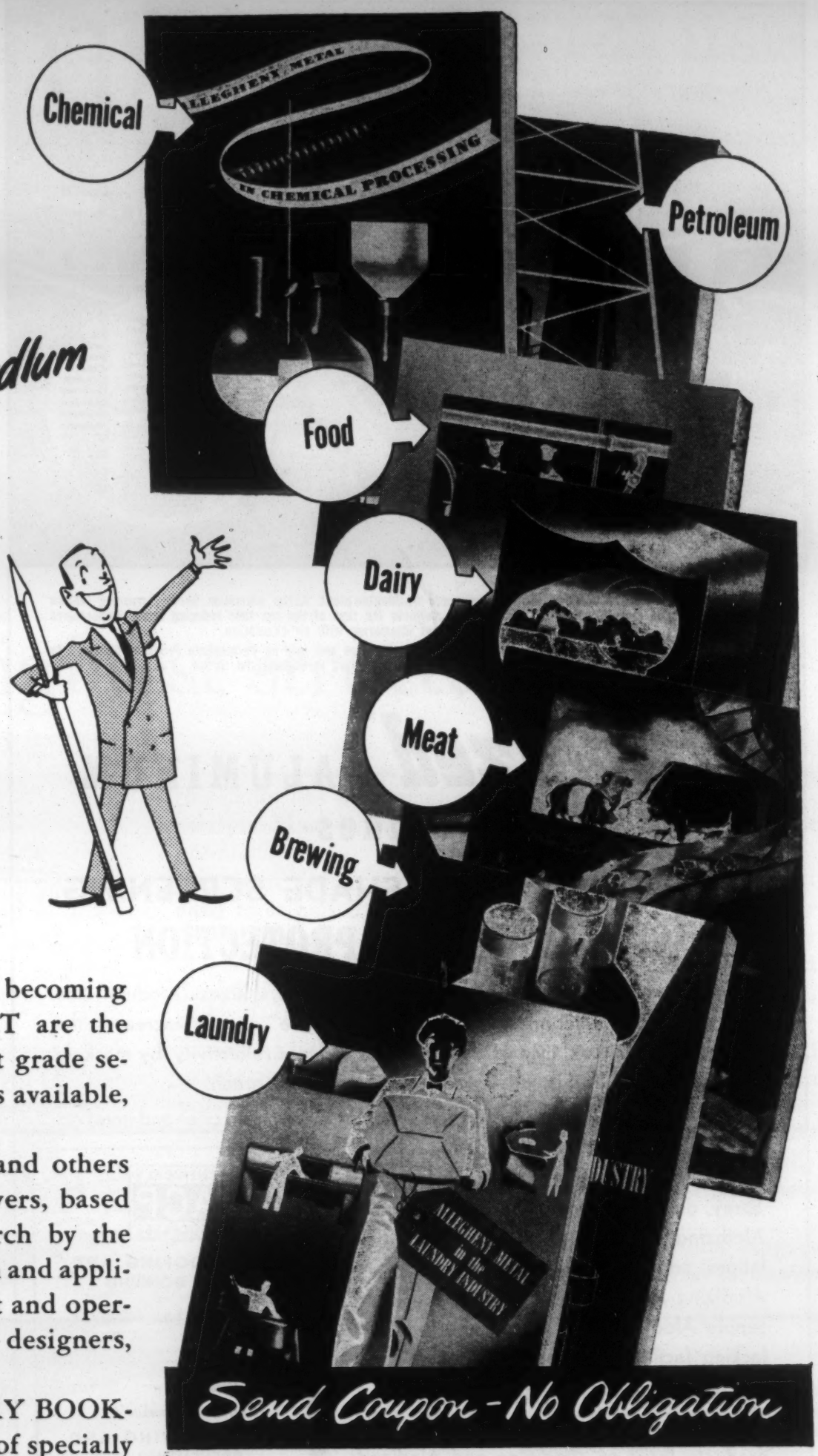
Injector Produces Wax Patterns for Industrial Precision Castings

A heavy-duty injector designed specially for volume production of wax patterns for industrial precision castings has been introduced by *Alexander Saunders & Co.*, New York City.

In the Sherwood Wax Injection Press the wax is extruded by direct piston drive activated by a hydraulic pump. Wax pressure may vary from 100 to 1500 psi. The wax is contained in cylinders carried in a revolving drum; while the wax is being discharged from one cylinder, the wax in

Take Your Pick of these Allegheny Ludlum Booklets on

Stainless in Industry



WHY is stainless steel equipment becoming so increasingly important? WHAT are the specific applications? HOW about grade selection, corrosion resistance, forms available, and fabrication?

The booklets illustrated here (and others in preparation) give you the answers, based on industry-wide data and research by the recognized authority on fabrication and application . . . valuable to management and operating men, technologists, buyers, designers, fabricators, and distributors.

Size 8½" x 11", the "INDUSTRY BOOKLETS" together contain a number of specially written articles, many pertinent photographs, charts and tables. *Mail the coupon!*

ALLEGHENY LUDLUM STEEL CORPORATION

The Nation's Leading Producer of Stainless Steels in All Forms

W&D 2729

PITTSBURGH, PA. . . . Offices in Principal Cities

Allegheny Metal is stocked by all Jos. T. Ryerson & Son, Inc., Warehouses

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Check the Industry Booklets you want, then attach this coupon to your letterhead and mail today to:

DEPT. MM-81 ALLEGHENY LUDLUM STEEL CORP., Pittsburgh 22, Pa.

(check all 7 if you wish)

☐ Brewing ☐ Chemical ☐ Dairy ☐ Food Processing
☐ Laundry ☐ Meat ☐ Petroleum

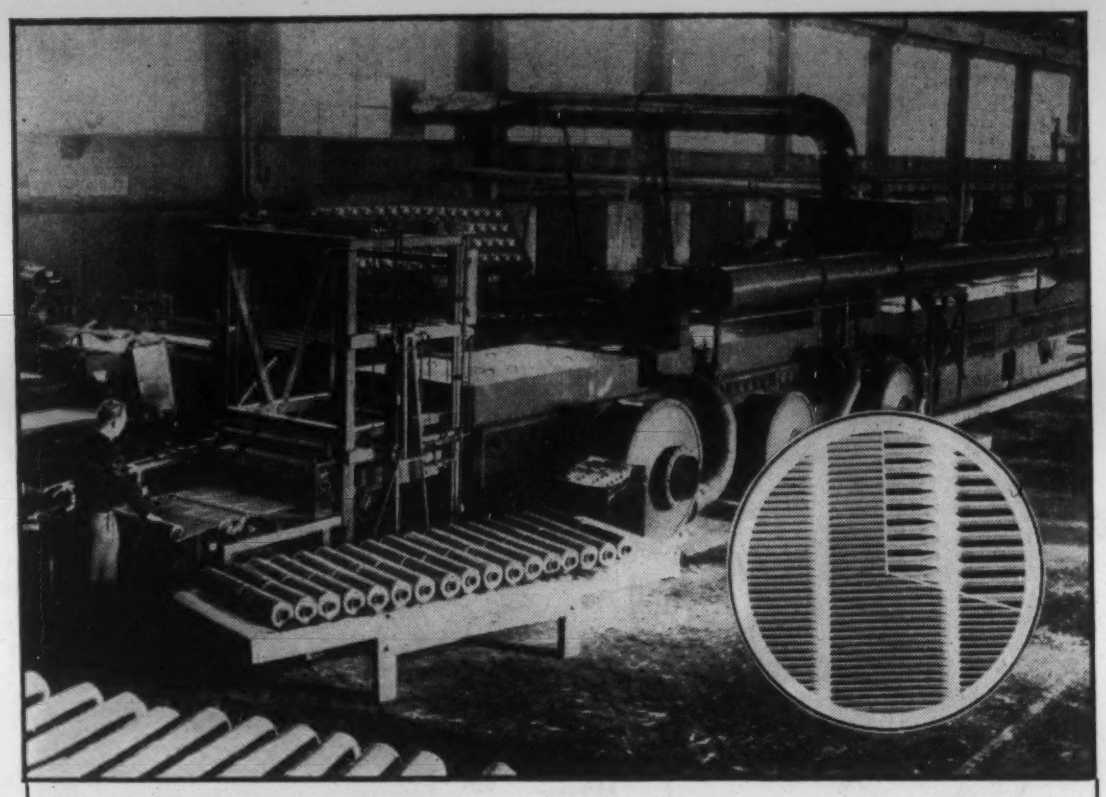
NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____



The Alodizing installation at Permanente's Trentwood, Washington plant. Kaiser Aluminum Shade Screening (shown in inset) excludes insects and, venetian-blind-wise, deflects the rays of the sun thus reducing room temperatures as much as 15° F. without interfering with air circulation.

This screening is produced by the Permanente Metals Corporation and sold by Permanente Products Company to screen manufacturers, distributors and dealers throughout the nation.

Alodized* **ALUMINUM**
provides
Kaiser Aluminum SHADE SCREENING
WITH MAXIMUM PROTECTION

Kaiser's new departure in screening, shown above, utilizes "Alodine"—the new development in metal protection. "Alodine" greatly increases the natural weather resistance of aluminum and reduces reflectivity by masking aluminum's metallic luster with a pleasing shade of green.

Alodizing is a purely chemical process—not an electrolytic one—and involves no elaborate apparatus. The coating solution is applied rapidly, uniformly and at low cost. Spray, dip, and even brush processes make Alodizing available to all kinds of installations; and manufacturers of aluminum are Alodizing on a huge scale at their mills to supply Alodized sheets and coils to plants lacking facilities for treating the metal.

"Alodine" promotes economy in production; and protects the quality of finished aluminum products. Insist on Alodizing and Alodized aluminum in your own fabrication. Write to us for further information on "Alodine".

* "Alodine" Trade Mark Reg. U. S. Pat. Off. by The American Chemical Paint Company.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
Granodine *
Duridine *
Alodine *
Lithoform *
Thermoil-Granodine *

RUST REMOVING AND PREVENTING
Deoxidine *
Peroline *

PICKLING ACID INHIBITORS
Rodine * ®

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
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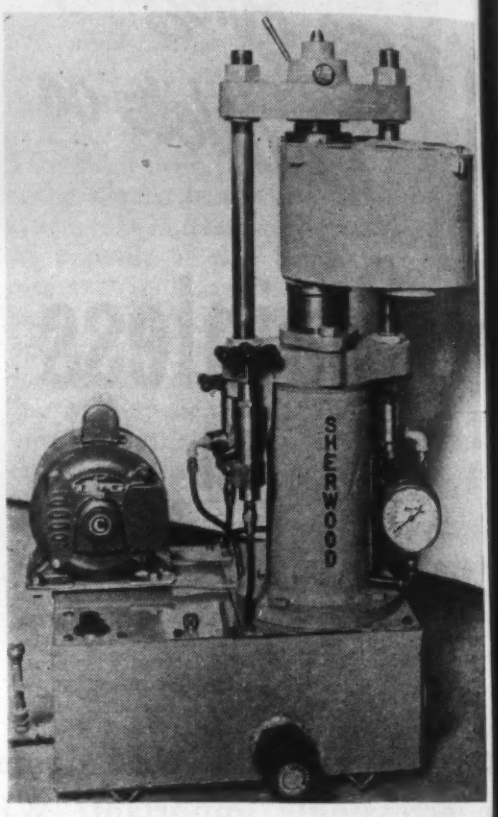
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

New Materials and Equipment

the other cylinders is being tempered for future use. This arrangement makes it possible to shift a new full cylinder quickly into position after a cylinder has been



Pressures from 100 to 1500 psi. are used in this Sherwood Wax Injection Press.

emptied. Each wax chamber has a capacity of 78 cu. in. The double-acting hydraulic pressure piston has a diameter of 4 in. and an effective stroke of 8 in.

The wax temperature, which can go as high as 400 F, is controlled thermostatically within ±2 deg. F of the desired temperature.

Rubber-Like Plastics Possess Improved Corrosion Resistance

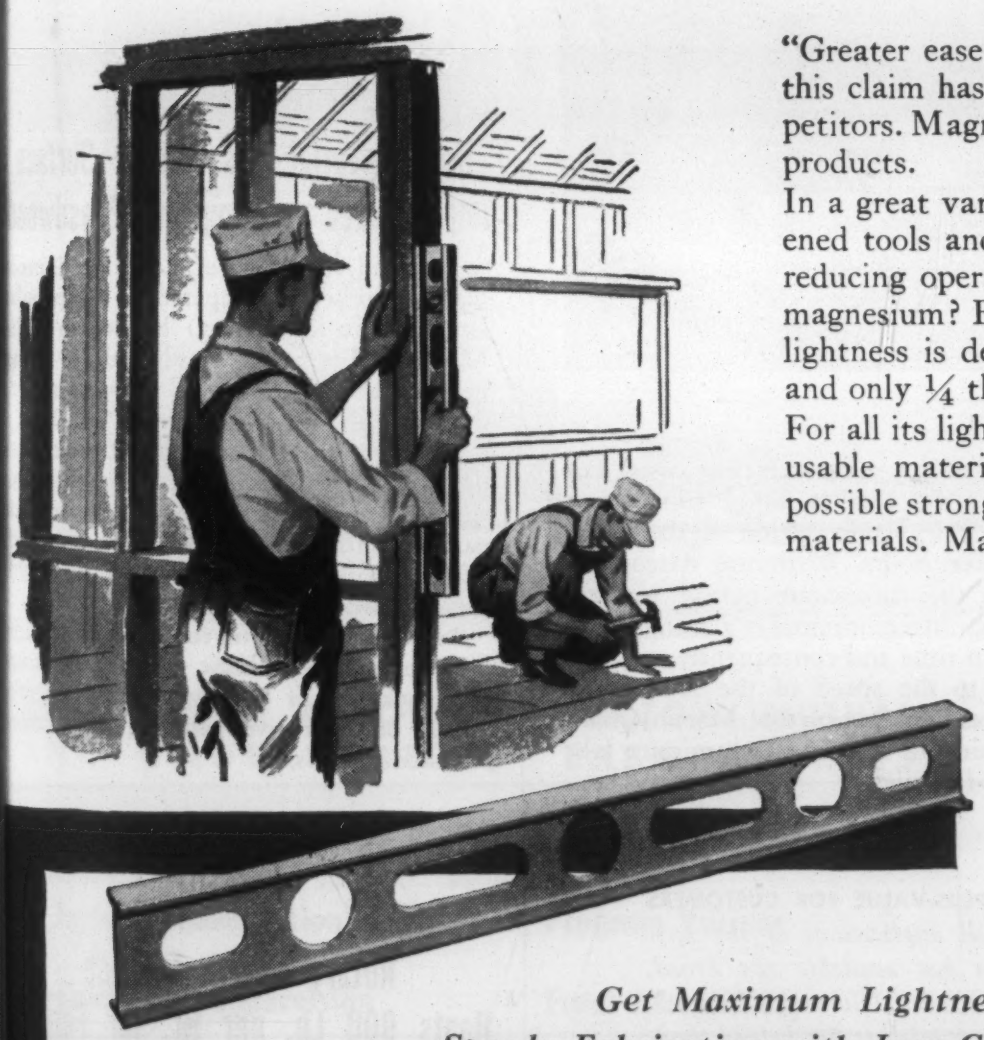
Rubber-like plastic materials, said to possess many chemical properties lacking in both natural and synthetic rubbers, have been developed by the *Organic Coatings Div.*, of *United Chromium, Inc.*, 51 E. 42 St., New York 17. Known as Unichrome Plastisol and Organosol Compounds, these materials are easily handled, possess high dielectric strength, and have high resistance to abrasion and to a wide variety of chemicals and corrosives.

The materials are available in paste-like form, Plastisols containing 100% solids and Organosols containing a small amount of

Noticeably greater ease in use comes with products made of Dow

MAGNESIUM

the world's lightest structural metal!



"Greater ease in use"—the product that can substantiate this claim has a tremendous sales advantage over its competitors. Magnesium has given this sales advantage to many products.

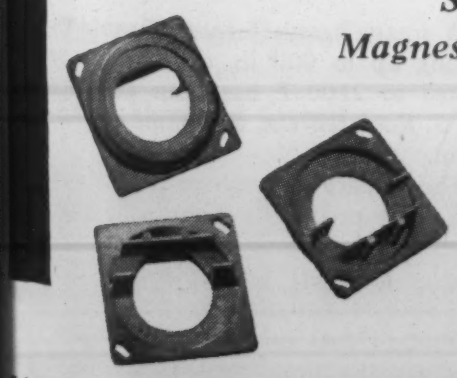
In a great variety of industrial fields magnesium has lightened tools and equipment, making them more efficient by reducing operator fatigue and increasing his output. Why magnesium? Because magnesium is the logical choice when lightness is desired. It's a full ⅓ lighter than aluminum, and only ¼ the weight of steel.

For all its lightness, magnesium is a remarkably strong and usable material. Its high strength-to-weight ratio makes possible strong, rigid designs with weight savings over other materials. Magnesium is readily available in all common forms and is easily and economically fabricated by well established shop procedures.

To see case studies showing how magnesium has improved products in many different fields, write for your free copy of "How Magnesium Pays."

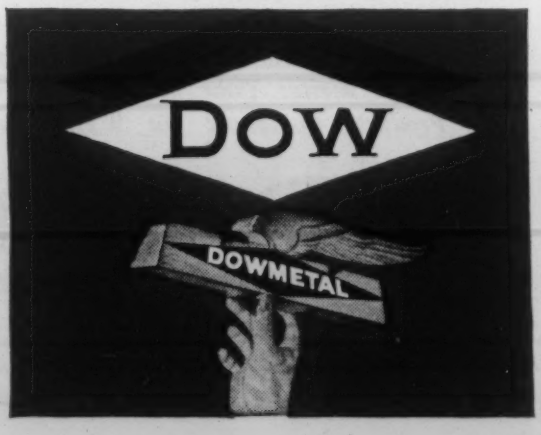
THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland
Detroit • Chicago • St. Louis • Houston • San Francisco
Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada



Get Maximum Lightness, Speedy Fabrication with Low Cost Magnesium Extrusions and Die Castings

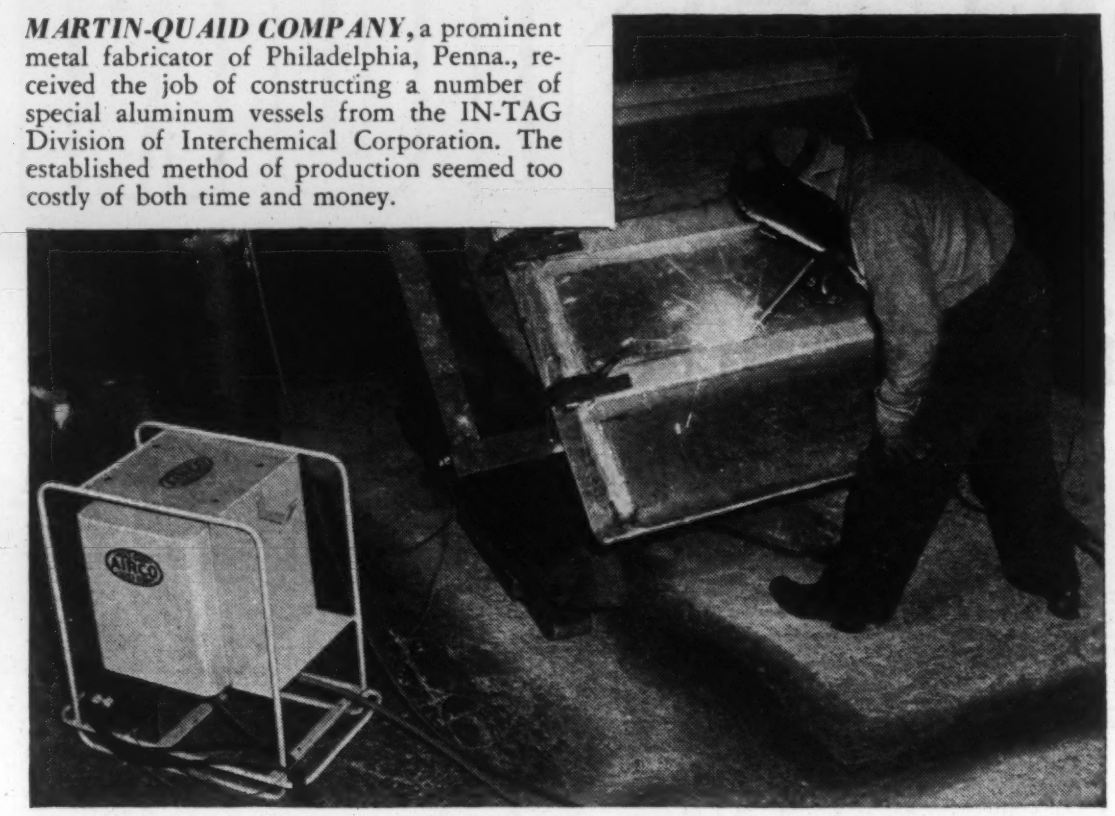
Wise manufacturers like the maker of this carpenter's level are profiting from the combined use of magnesium extrusions and die castings. Low cost magnesium extrusions are used to replace more costly formed or fabricated sections, while die cast magnesium parts greatly reduce the machining required because of their good surface finish and excellent dimensional accuracy.



Lighter Products Sell—make your product Magnesium Light

new aircomatic process does three hours' work in fifteen minutes

MARTIN-QUAID COMPANY, a prominent metal fabricator of Philadelphia, Penna., received the job of constructing a number of special aluminum vessels from the IN-TAG Division of Interchemical Corporation. The established method of production seemed too costly of both time and money.



Dana V. Wilcox, Airco Technical Sales Representative, recommended the *new* Aircomatic Process with Airco Helium. Aluminum alloy ½" and ¾" thicknesses was used. The suggestion was adopted, and the process was applied to the job on a production basis.

Prior to the introduction of the new Aircomatic Process, Martin-Quaid used another arc welding method, but found welding time to be a disproportionate amount of its manufacturing costs. For example, the total welding time for a 4′ x 5′ x ½" side section of the vessel took three hours. With the Aircomatic Process, the three-hour period was reduced to fifteen minutes — a tremendous saving in time and consequently cost.

Due to the speed of the Aircomatic Process as a production tool, Martin-Quaid is planning to expand its aluminum fabrication facilities.

• • • •

TECHNICAL SALES SERVICE — ANOTHER AIRCO PLUS-VALUE FOR CUSTOMERS

To assure its customers of high efficiency in all applications of the oxy-acetylene flame or electric arc, Air Reduction has available the broad, practical experience of its nationwide Technical Sales Division personnel. The collective experience and knowledge of these specialists has helped thousands to a more effective use of Airco processes and products. Profit by this Airco "Plus-Value" service. Ask to have a Technical Sales Division man call today. Write: Your nearest Airco office. In Texas: Magnolia Airco Gas Products Company. On West Coast: Air Reduction Pacific Company.

AIRCO **AIR REDUCTION**

Offices in Principal Cities

Headquarters for Oxygen, Acetylene and Other Gases... Calcium Carbide... Gas Cutting Machines... Gas Welding Apparatus and Supplies ... Arc Welders, Electrodes and Accessories

New Materials and Equipment

liquid solvent or diluent. The plastics can be molded or applied as coatings to metal, fabric or paper by dipping, spraying or brushing; a single application will produce coatings from 0.003 to 0.25 in. thick. Upon baking 20 to 30 min. at 350 F, the materials set and assume a rubber-like appearance.

The cured compounds resist acids, alkalis, salt solutions, oils, gasoline, greases, industrial oxidants, and a number of other types of chemicals and products normally corrosive to rubber. They have been used on pipes, tanks, drums, work carriers, tool handles, cotton gloves, protective clothing and process equipment.

New Material Has Plastic Surface Impregnated on Tempered Presdwood

Lamidall, consisting of a tough stainproof plastic surface (comparable to popular laminates on the market) bonded to ⅛-in. Masonite Tempered Presdwood, is being manufactured by *Woodall Industries, Inc.*, 2025 S. Calumet Ave., Chicago 16, Ill.

The new material is made in panel sizes up to 4 by 12 ft. and can be fabricated to specification in desired shapes or sizes for parts or finished products. It can be sawed, shaped, nailed, punched or drilled with standard wood working tools.

Lamidall is said to combine the wearability of a tough plastic surface, the structural qualities of Presdwood, and the eye-appeal of distinctive patterns, solid colors and wood grains.

Rotary Hearth Furnace Heats 900 Lb. per Hr. for Forging

A rotary hearth furnace capable of producing up to 900 lb. of forgings per hr. heated to 2100 F has been developed by *W. S. Rockwell Co.*, 200 Eliot St., Fairfield, Conn.

The furnace atmosphere is carefully controlled to produce a light scale that will flake off easily with the first blow of the forging hammer. This is accomplished by gas burners designed to permit a slight amount of fuel oil to be introduced into the furnace atmosphere during the heating operation. Usual heating time is from 12 to

Now-Safer than ever!

Read the Facts About the New Model 1300 FLAME-OTROL

Learn... how the Wheelco FLAME-OTROL now renders more positive and dependable protection to all types of gas and oil fired heating equipment from safe-start to safe shut-off:

...how the many new protective features of this improved Wheelco FLAME-OTROL give you a Combustion Safeguard—"safer than ever."

APPROVED BY ASSOCIATED FACTORY MUTUAL AND UNDERWRITERS' LABORATORIES

- ✓ Guaranteed Safe-Start
- ✓ Instantaneous Action
- ✓ Continuous Supervision
- ✓ Versatility of Operation
- ✓ Fully Shielded Circuit
- ✓ Design Simplicity
- ✓ Program Variety
- ✓ Front Accessibility
- ✓ Voltage Selector Plugs
- ✓ Blue Sensitive Cell

WHEELCO INSTRUMENTS COMPANY
861 W. Harrison St. • Chicago 7, Illinois

Please send me Bulletin F2-1

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Company_____

Street_____

City_____ Zone___ State_____

WHEELCO *Electronic* CONTROLS

RECORDERS • COMBUSTION SAFEGUARDS • CONTROLLERS

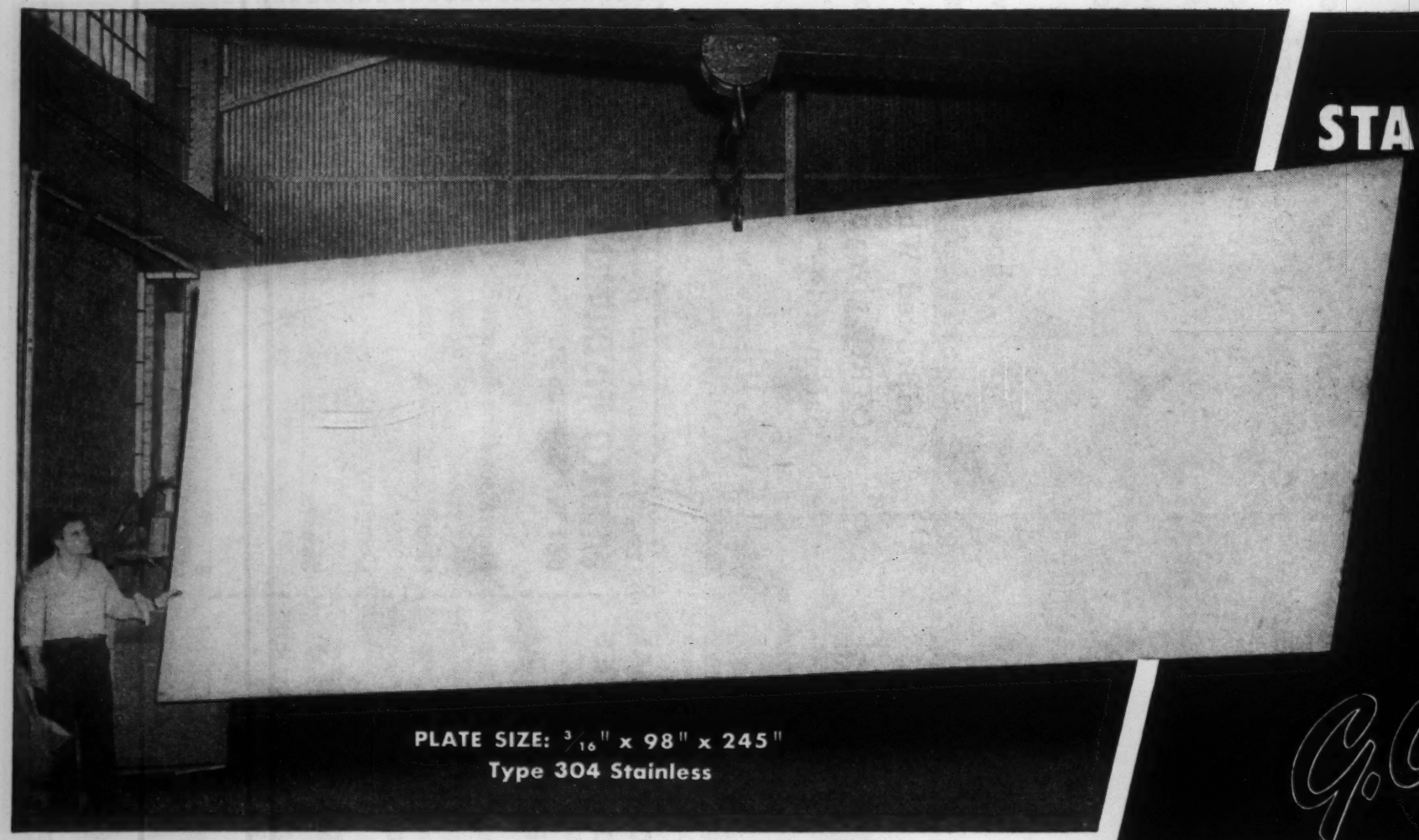


PLATE SIZE: $\frac{3}{16}$" x 98" x 245"
Type 304 Stainless

CARLSON STAINLESS STEEL PLATES IN STOCK

There is nothing unusual about this Carlson stainless steel plate—it is typical of our stock at all times in the active grades—quality always to chemical industry standards.

From these large stock plates we produce pattern cut shapes and diameters in any size to your requirements—or deliver the entire plate if desired. Larger plates and patterns can be rolled to your order.

More and more, users of stainless steels come to G. O. Carlson, Inc. for quality and exceptional service. It will pay you to send us your inquiries for plates, patterns and shapes.

G. O. CARLSON, INC.

Stainless Steels Exclusively

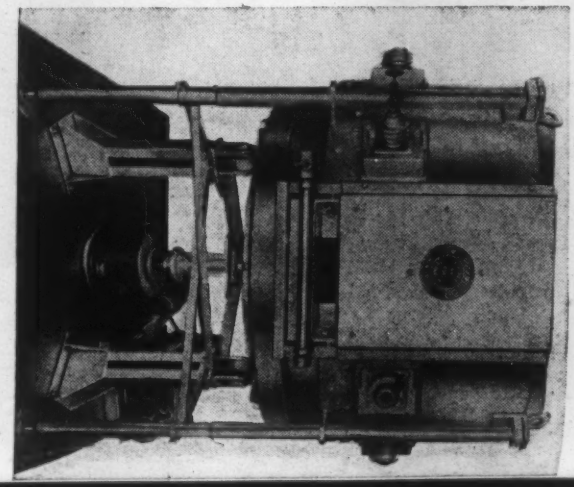
200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

District Sales Offices and Warehouse Distributors in Principal Cities

The CARLSON WEEKLY STOCK LIST keeps you posted on what plates are available for immediate shipment. We'll gladly put your name on the list.

New Materials and Equipment



Close atmosphere control is a feature of the new Rockwell furnace.

36 min., but can be easily changed to longer or shorter cycle.

The work is charged and discharged through a single slot 9 in. wide and 2½ in. high. This slot has a water-cooled sill that prevents the heat from creeping back along the bar.

The furnace is completely sealed against air infiltration. It can be readily adapted to heat treating of small parts by the addition of a door in place of the slot.

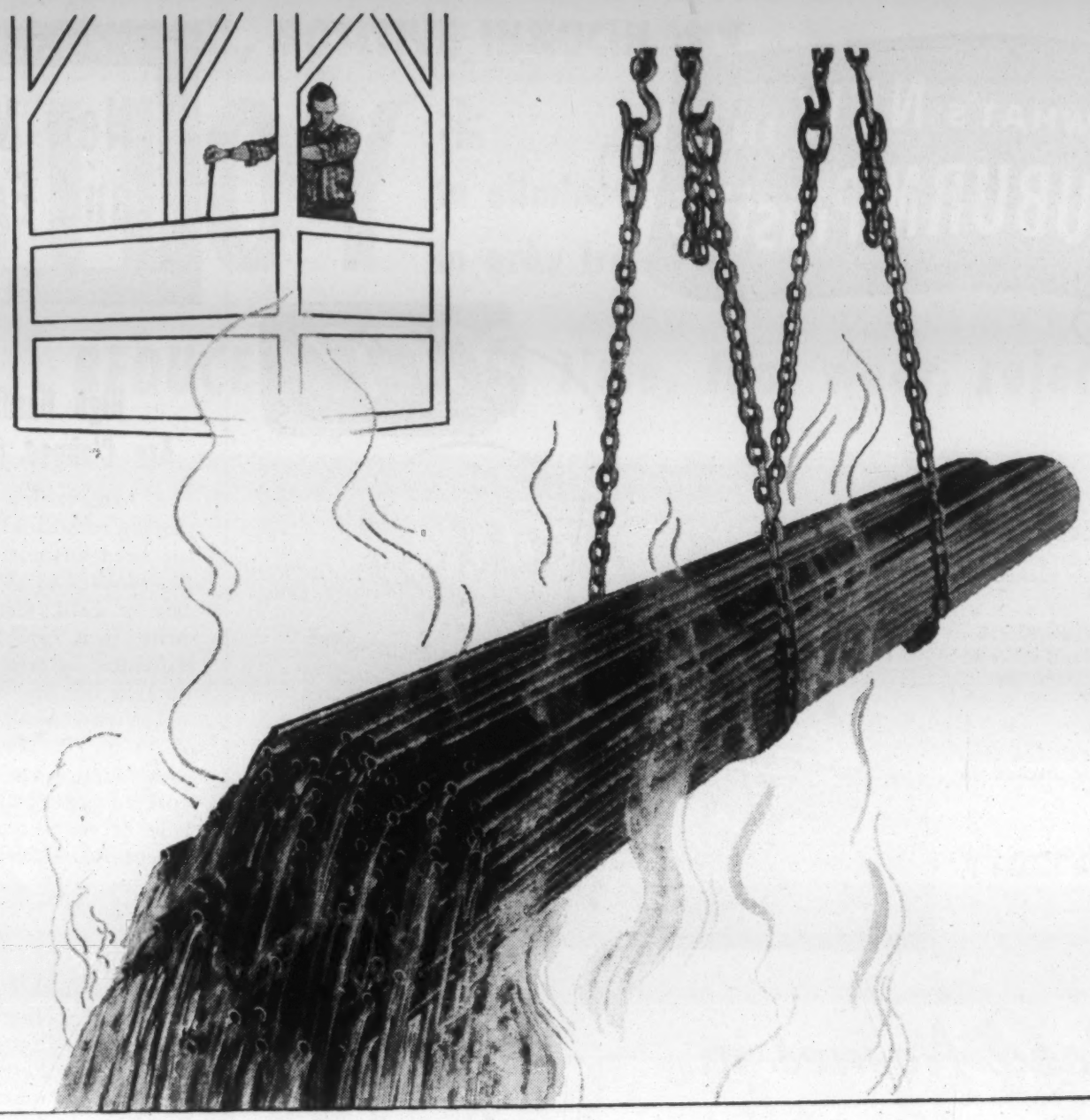
One-man operation, low fuel costs, uniform heating cycle and high output per square foot and floor space are claimed for this equipment.

Equipment Package Designed for Small Soldering, Brazing Jobs

Small soldering, low-temperature brazing, heating or lead-burning jobs can be performed with the No. 75 Air-Acetylene Outfit prepared by *Air Reduction Sales Co.*, 60 E. 42 St., New York 17.

The outfit includes brass torch assembly, four tips, 5 ft. of 3/16-in. flexible hose, a soldering iron, and soldering copper. The four tips are: radiator soldering tip whose slender tubing permits the flame to be used in confined places; No. 9 for medium flames; No. 10 for pointed flames suitable for concentrated heating; and No. 15, which gives a brush-type flame suitable for heating broad areas.

(Continued on page 110)



"We have no fear of any sudden breaks with Monel Pickling Chain on the job!"

You'll always find pickling-room foremen confident of safety with Monel* chain.

Take the chain shown above. It's ¾" Monel, and has been in pickling service over 6 years. In the same plant is another chain, a 1¼" cast acid-resisting chain. Yet, for the heaviest loads, they use the lighter Monel chain because "*. . . we find it reliable and not subject to sudden breaks, as is the case with the cast acid-resisting chain.*"

For over 40 years, Monel has paid its way in pickling service, because Monel resists corrosion by hot pickling acids and fumes. It's stronger and tougher than structural steel. And, Monel welds retain full strength, full corrosion resistance.

So, whether you use chain as slings or in mechanical picklers . . . for longer life and greater safety that chain should be *Monel!*

*Reg. U. S. Pat. Off.

DESIGNERS and MANUFACTURERS! Sand castings and precision castings of Monel, Nickel, Inconel* and other Nickel alloys are available from INCO's own foundry.

"PICK" MONEL *for all types of pickling equipment. In addition to chain, you can have crates, baskets, tie-rods, hairpin hooks and other pieces fabricated to your design out of economical standard mill forms. For more information on Monel and Monel fabricators, write to our Ray Reddell.*

EMBLEM OF SERVICE
INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N. Y.

"MONEL*" Pickling Equipment means *Extra* CAPACITY . . . *Extra* LIFE . . . *Extra* SAFETY

WHAT'S NEW IN AUBURN Plastics

RECORDAK
Red design, clear plastic backed by silver

WESTINGHOUSE
Gold and white design, clear maroon plastic

I-T-E
Silver design, clear plastic backed by black

IBM
Black design, clear plastic backed by gray

Good Names in *Good Nameplates...*

ATTRACTIVE... The design with three-dimensional effect—in any colors—is embedded in lustrous clear plastic. "Crystal Seal" process nameplates are solid shapes of transparent acrylic plastic (Lucite or Plexiglas) with recessed molding in the reverse side. Colors sprayed on the reverse side, using a masking process, bring out the design. Additional color on the back accentuates the contrast and reflects light—or, if there is to be a backlight, the rest of the plate may be left clear.

INEXPENSIVE... Special equipment set up at Auburn, Eastern licensee for the "Crystal Seal" process, permits economical production. Because the colors are inside—bound to the basic plastic form—there is no deterioration from fumes, dirt, or wear. "Crystal Seal" pieces last practically forever. The process is ideal for nameplates, plaques, dials, trim, containers, knobs, insignia, point of sale displays, and a host of other applications where you want permanent good looks at low cost.

Through 73 years of experience Auburn has developed "know-how" that's at your service in the solution of problems involving plastics and their *molding by any method.* Write Auburn Button Works, 410 McMaster St., Auburn, N. Y.

Auburn Engineered Plastics

MOLD MARK

COMPRESSION, TRANSFER, AND INJECTION MOLDING, AUTOMATIC ROTARY MOLDING FOR MASS PRODUCTION, EXTRUDED ELASTOMERICS, REINFORCED PLASTICS (Fiberglas), MOLD ENGINEERING AND COMPLETE MOLD SHOP

Auburn Button Works, Inc.

MOLDERS SINCE 1876 • AUBURN, NEW YORK

New Materials and Equipment

High Hardness, Durability Are Claimed for Casting Plastic

A hard casting plastic, Calcerite-A, employing substantially amino-resins as binders has been announced by *Furane Plastics & Chemicals Co.*, 719 W. Broadway, Glendale 4, Calif. Compared to standard Calcerite, it is said to offer improved water resistance, greater strength, and longer working life.

The new product has a Barco hardness of 65 to 70. When reinforced with glass flock fillers, it can withstand relatively high working temperatures. Calcerite-A cures fully at room temperature and has high dimensional stability.

● A cast nickel alloy, free of copper or iron, and having a tensile strength of 50,000 to 60,000 psi., has been announced by *Waukesha Foundry Co.*, Waukesha, Wis. Known as "Waukesha Metal" Alloy No. 23, the patented composition has an elongation of 7 to 10% and Brinell hardness of 145 to 165 (3000 kg. load). Special properties are high corrosion resistance, good machinability and good anti-seizure characteristics.

Leaded Open Hearth Screw Steel Has Improved Machinability

A leaded, free-machining steel known as Ledloy is again being marketed by *Joseph T. Ryerson & Son, Inc.*, Box 8000-A, Chicago 80. Although a machinability rating for Ledloy has not been established, the new steel is claimed to machine from 30 to 50% faster than AISI B1113 which, until recently, has been accepted as the fastest cutting screw steel.

Composition of the alloy has not been made known, but it is undoubtedly similar to the "E" steel and La-Led compositions announced in the last few months by Jones & Laughlin Steel Corp. and LaSalle Steel Co., respectively. Production of leaded steels was curtailed during the war and in the post-war period, and only recently has manufacture been resumed.

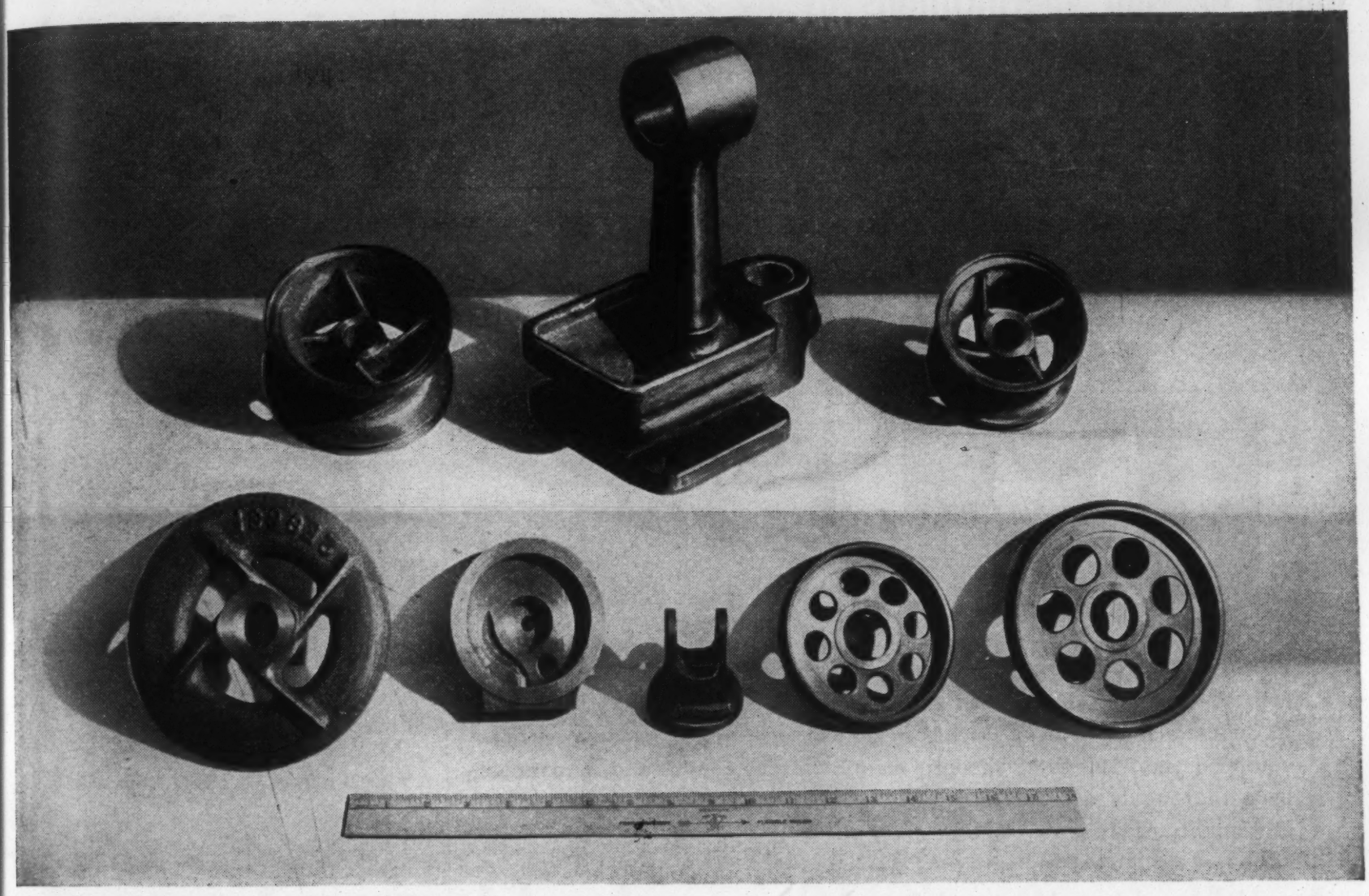
Cutting tools used on Ledloy are said to last from 50 to 200% longer between grinding. Ledloy is also claimed to provide a smoother finish and better base for plating than other free-cutting screw steels. Because it is an open hearth steel, it has good strength and ductility and will carburize better and have a sounder cross section than free-machining Bessemer steels.

SPECIFY THIS POWERFUL, POSITIVE INNOCULANT

NISILOY*

to eliminate hard chilled areas
in gray iron castings

. . . REDUCE machining time, tool wear, rejections



Produce *machinable* gray iron castings regardless of sharp variations in section thickness . . .

Eliminate localized hard areas or chilled (white) edges and surfaces . . .

Reduce machining time, tool wear and rejections . . . *raise both quality and quantity of your output by controlling gray iron structure with small ladle additions of NISILOY.*

Designed specifically to promote better machinability, NISILOY is a powerful innoculant and graphitizer containing about 60% Nickel, 30% silicon, balance essentially iron.

*Trade Mark of The International Nickel Company, Inc.

Mail the coupon now . . . for your *free* copy of a booklet that describes how Nisiloy helps you improve structure and machinability of gray iron castings.

EMBLEM OF INCO SERVICE
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
Dept. M. M., 67 Wall Street, New York 5, N. Y.

Please send me your booklet entitled,
"NISILOY" for GRAY IRON CASTINGS.

Name.....*Title*.....

Company.....

Address.....

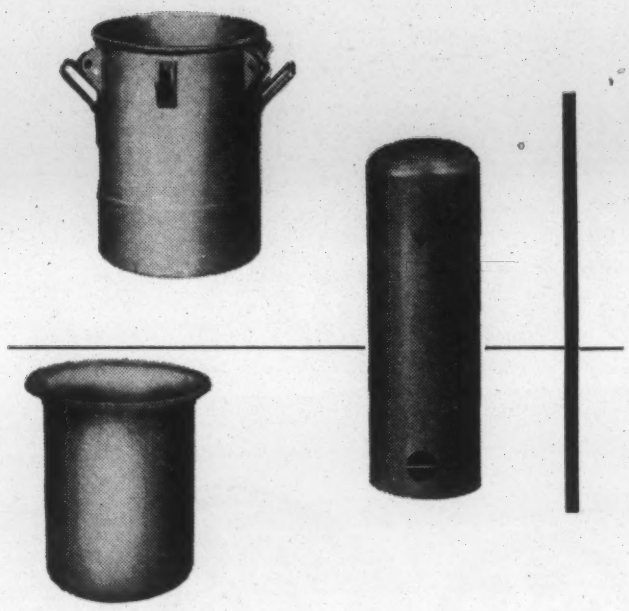
City.....*State*.....

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET
NEW YORK 5, N. Y.

Prest-O-Lite
Trade-Mark

Cold-Drawn SHAPES and SHELLS

made to your specifications by *Linde*



Leaders of the Field for Over 35 Years

PREST-O-LITE cold-drawn shapes and shells can be quickly and economically produced to your most rigid specifications—from 1½ to 23 inches in diameter and up to 50 inches in depth. Our greatly expanded, well-equipped plant has every modern manufacturing facility and is manned by a thoroughly experienced, highly specialized staff—prime requisites of a quality product.

LINDE engineers will gladly help you solve your production and design problems involving cold-drawn shells, cups, containers, receivers, pressure vessels, formed parts, or other shapes.

The term "Prest-O-Lite" is a trade-mark of The Linde Air Products Company.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Principal Cities

In Canada: DOMINION OXYGEN COMPANY, Limited, Toronto

The Linde Air Products Company
30 East 42nd Street
New York 17, N. Y.

Please send literature and full information about cold-drawn shapes and shells.

NAME _____

COMPANY _____

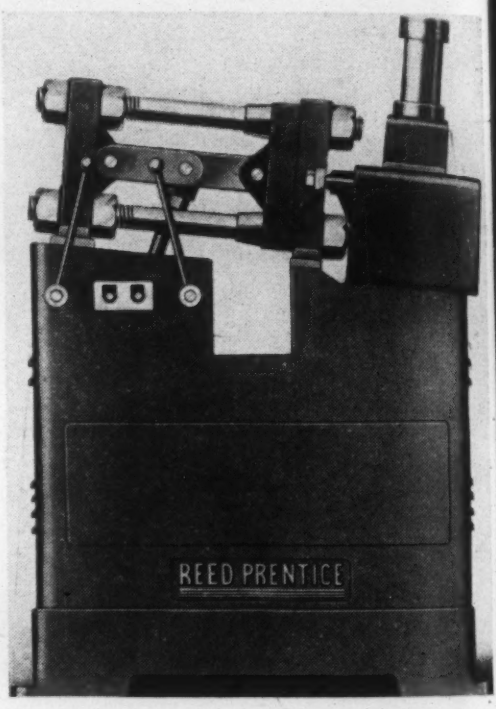
ADDRESS _____

New Materials and Equipment

Lead, Tin or Zinc Alloys Die Cast by Small Self-Contained Machine

High-speed production of die castings of lead-, tin- or zinc-base alloys is made possible by a small, self-contained machine manufactured by *Reed-Prentice Corp.*, Dept. D-1, Worcester 4, Mass.

Designated Model No. 0, the new die casting unit has a maximum shot capacity of 1 lb. of zinc, and will produce up to



This Reed-Prentice die casting machine will produce up to 600 shots per hr.

600 shots per hr. The capacity and speed of this machine make it ideal for rapid, continuous production of small pieces such as knobs, handles, gears and fittings.

Die plates measuring 10 by 10 in. provide a maximum casting area of 9 sq. in. at 1300 psi. The holding pot into which the molten metal is ladled has a capacity of 75 lb. of zinc. Machine dimensions are 33 by 12 by 44¾ in.

The machine is manually operated by hydraulic pilot valve control levers. Plunger control is interlocked to prevent making the shot unless the dies are closed.

● *Kester Solder Co.*, 4201 Wrightwood Ave., Chicago 39, is now supplying solder preformed in rings, pellets, washers, and unusual shapes and sizes to specifications. Solder preforms are used to assure uniform results where continuous or repetitive soldering is required.

Tru-Spot Flashlight—*made from Kaiser Aluminum* by Ekco Products Company, 1949 North Cicero Ave., Chicago, 39. The one-piece seamless case is 6⅜ inches long, 1½ inches in diameter, with a flared top 2 inches in diameter.

Drawn from a blank...with no annealing!

In eight easy stages the Tru-Spot Flashlight case is drawn from a blank of Kaiser Aluminum—*automatically*—without a single anneal!

Consistent high quality and workability of Kaiser Aluminum make this operation successful and economical—and give Ekco profitable advantages like these:

Lower manufacturing costs—due to elimination of many steps in handling and fabricating. Low cost tooling set-up—because Ekco uses exactly the same equipment formerly used for a more expensive metal!

Scrap loss is cut. Plating is unnecessary because a bright, lasting finish is produced merely by buffing!

And the sturdy seamless case has unmatched sales appeal!

No matter what fabricating method *you* use, chances are you can profit with Kaiser Aluminum—the *versatile* metal that combines strength, durability, lightness, workability. Call any Permanente Products' sales office for more information.

Permanente Metals

PRODUCER OF

Kaiser Aluminum

SOLD BY PERMANENTE PRODUCTS COMPANY, KAISER BUILDING, OAKLAND 12, CALIFORNIA . . . OFFICES IN: Atlanta • Boston • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Kansas City • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Portland, Ore. • Rochester, N.Y. • Seattle • Spokane • St. Louis • Wichita
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ANOTHER 3M COMPANY NEWS STORY

A helping hand to Hires new dispensers

Pleasing and welcome sight . . . those clean, sparkling Hires dispensers. And 3M Adhesives help make and keep them so despite low operating temperatures, inevitable spillage and hard use.

CORK INSULATION keeps them cool—and a 3M Adhesive does a double-barreled job. It seals the cork against moisture penetration and consequent loss of insulating efficiency. It also eliminates slow-to-assemble, heat transferring mechanical fasteners. The "adhesive method" speeds production AND makes a better unit.

ANOTHER 3M ADHESIVE bonds a rubber gasket to the metal case. Unaffected by cold or moisture, this adhesive always remains resilient to absorb the gasket's flexing—to keep the gasket from popping off.

These are just two of the more than a 1000 adhesives, coatings and sealers the 3M Company compounds... specific products for critical jobs. If you have an adhesive or sealing problem, ask for our free consultation service. Just write the Adhesives and Coatings Division, Dept. M119, Detroit.

3M BRAND ® ADHESIVES

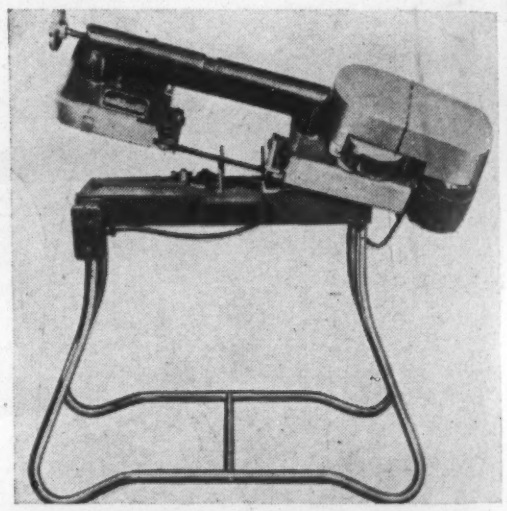
MINNESOTA MINING & MFG. CO.
Also makers of "Scotch" Brand Pressure-sensitive Tapes, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives.
General Offices: St. Paul 6, Minnesota
Adhesives and Coatings Division, Detroit 2, Michigan
General Export: Durex Abrasives Corp., New Rochelle, N. Y.
In Canada: Canadian Durex Abrasives Ltd., Brantford, Ontario

New Materials and Equipment

Horizontal Metal-Cutting Band Saw Built Especially for Small Shops

Wells Manufacturing Corp., 380 Service Rd., Three Rivers, Mich., has announced production of a small horizontal metal-cutting band saw. The saw has a capacity of 3½ in. for rounds and 3½ by 6⅜ in. for rectangular shapes. Known as Model 49A, it is designed especially for small shops and for general utility work in larger shops.

Bed area of 49A is 6½ by 24 in. Height to top of bed is 24 in. Floor space requirement is 16½ by 38 in., and net weight is about 118 lb.



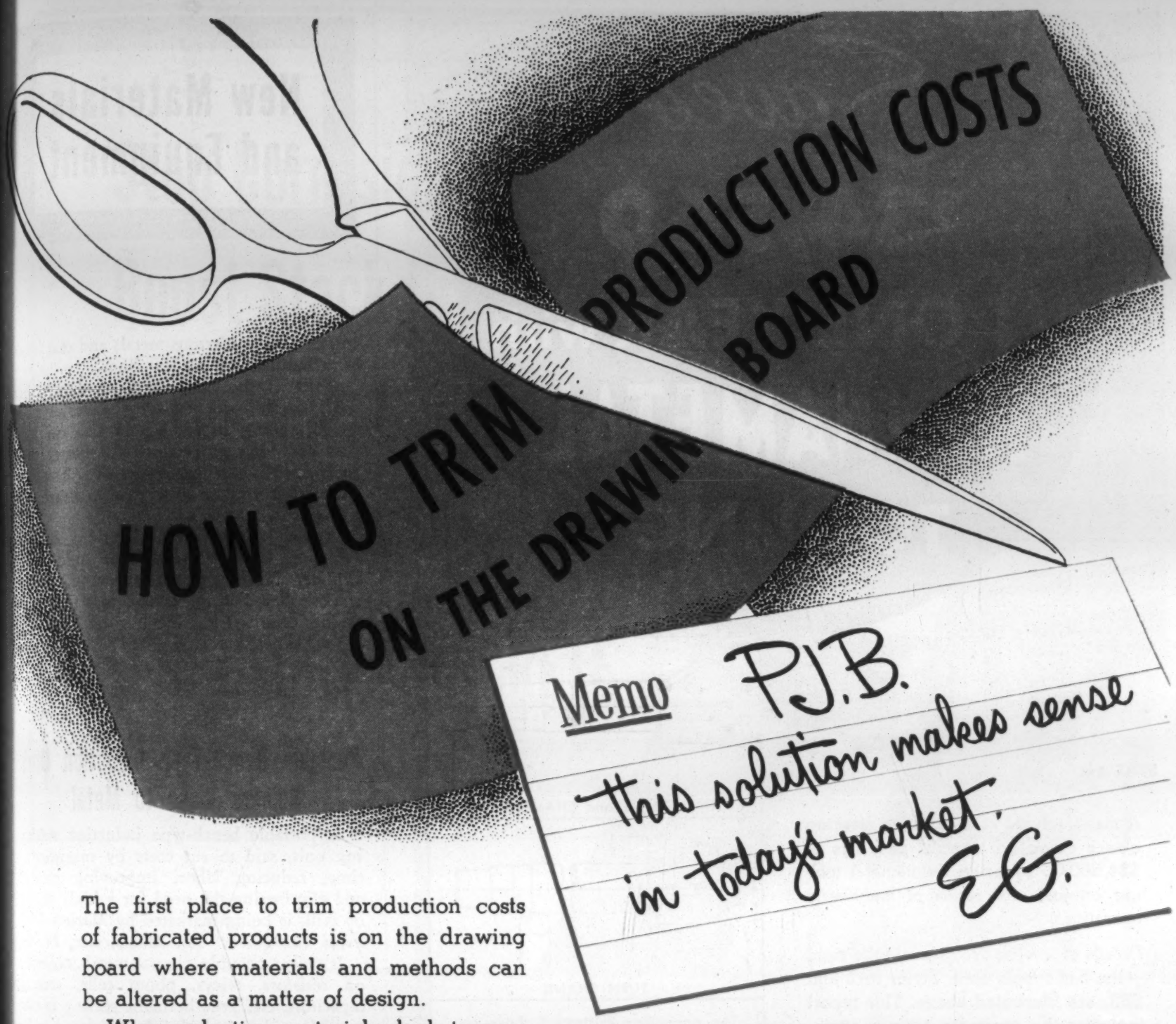
This Wells band saw cuts 3½-in. rounds and 3½ by 6⅜-in. rectangular shapes.

The blade (½ in. by 0.025 in. by 5 ft.) is driven by a 1/6-h.p. ball bearing motor with manual start and automatic stop. A V-Belt drive provides selective speeds of 54, 100 and 190 ft. per min. The saw is also equipped with a quick-action vise and adjustable blade guides.

Improved Cemented Carbide Grade Makes Possible Longer Tool Life

Recent improvements on Grade 905 of Carboloy cemented carbide are said to provide higher hardness, more wear resistance, greater cutting edge strength and cratering resistance, and more rapid dissipation of heat at the cutting edge. Manufactured by *Carboloy Co., Inc.*, Detroit 32, Mich., Grade 905 is used for finishing and light roughen-

(Continued on page 120)

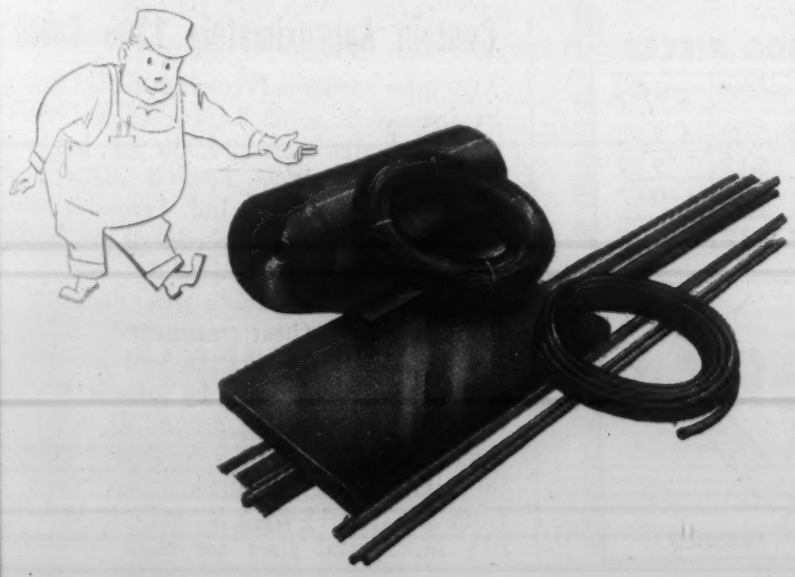


The first place to trim production costs of fabricated products is on the drawing board where materials and methods can be altered as a matter of design.

When selecting materials, look to genuine Hussey Copper to give fabricating economies that keep production costs low. Hussey Copper will stamp, form, turn or spin to any shape with the lightest of equipment. It will solder, braze, crimp, rivet, bolt, screw; or laminate to other materials.

Hussey Copper offers utmost versatility, too. With it you can obtain electrical or thermal conductivity, corrosion resistance, lifetime durability, lasting beauty and decoration, and acknowledged top quality.

To trim production costs, design with Hussey Copper. Use its most advantageous form—sheet, coils, rod, wire or tubing. There's a supply near your manufacturer in any of Hussey's seven complete warehouses.



C. G. HUSSEY & COMPANY
(Division of Copper Range Co.)
ROLLING MILLS AND GENERAL OFFICES
PITTSBURGH, PA.

Hussey Warehouses carry stocks of Copper and Brass Products for Prompt Shipment

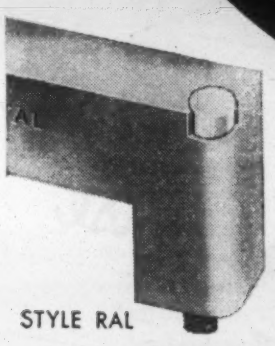
7 convenient warehouses to serve you promptly!

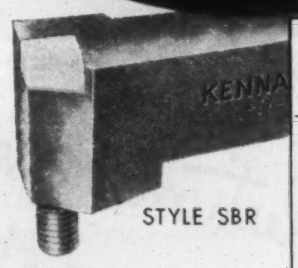
PITTSBURGH, 2850 Second Avenue • CLEVLAND, 5318 St. Clair Avenue • NEW YORK, 140 Sixth Avenue • CHICAGO, 3900 N. Elston Avenue • ST. LOUIS, 1620 Delmar Boulevard • PHILADELPHIA, 1632 Fairmount Avenue • CINCINNATI, 424 Commercial Square

HUSSEY

OUR 101st YEAR!

Saves $34,560 IN ONE YEAR with KENNAMETAL TOOLING



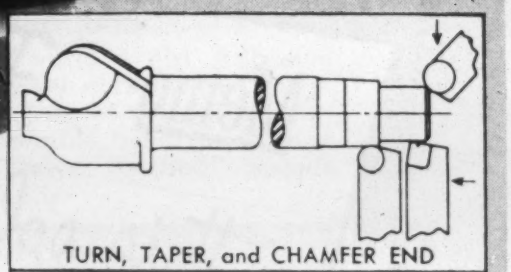


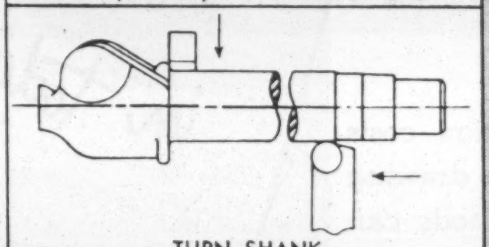
A manufacturer of automotive steering gears effected annual savings of $34,560.00 by using Kennametal tooling on just one series of machining operations.

Details of the job are given at the right —the basic tools used, Styles RAL and SBR, are illustrated above. This report indicates the enormous savings attainable through the application of modern tooling.

Here again Kennametal proves its worth. A few pennies saved in the initial cost means nothing. Consider these facts: (1) Fewer tools are required, as a rule; (2) Set-up and machine downtime are minimized; (3) Load and confusion in grinding room is reduced; (4) Higher production rates can be reached, and maintained.

Ask us to send you performance reports that show how other shops are achieving cost reduction by tooling with Kennametal.





The operations illustrated above required ten single-point brazed tools. Four Kennamatic tools are now being used. The savings on each 1000 pieces machined is $24.00, as detailed below. A total savings of $34,560.00 was realized over a 12-month period.

TOOL PERFORMANCE

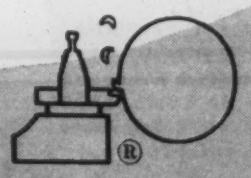
	Single-Point	Kennamatic
Number Required	10	4
Cost Each (Avg.)	$2.50	$4.10
Pieces/Grind	200	1,600
Pieces/Tool Life	2,000	24,000

SHOP COST/1000 PIECES

	Single-Point	Kennamatic
Tool Cost	$15.00	$ 1.93
Productive Labor	15.12	9.32
Non-Productive Labor	6.00	0.87
Shop Cost/1000 pcs.	$36.12	$12.12

ROUGH FORGING

FINISHED



KENNAMETAL Inc.
LATROBE, PA.
MANUFACTURERS OF SUPERIOR CEMENTED CARBIDES AND CUTTING TOOLS THAT INCREASE PRODUCTIVITY

New Materials and Equipment

ing cuts on nonferrous metals and cast irons with hardness up to 550 Bhn.

Tests by the company have shown that tools tipped with the new material have longer service life and hold size on long cuts and high production jobs better than tools tipped with the former 905. The new material is said to be as easy to braze and grind as the old 905.

Among the varied applications of this cemented carbide product are automotive cylinder boring, piston grooving, tractor track roller boring, clutch pressure plate facing, camshaft bearing turning, etc.

Portable Bench-Type Induction Unit Solders Glass to Metal

A portable bench-type induction soldering unit, said to cut costs by minimizing time, reducing labor, improving quality and eliminating the need for a high degree of skill, is being marketed by *Marion Electrical Instrument Co.*, Manchester, N. H.

It makes possible glass-to-metal soldering on resistors, relays, photo cells, meters, capacitors, etc. True hermetic sealing is also possible with this device. It is claimed to be ideal for terminal, magnet and bearing assembly.

The unit draws 775 watts at full power and 100 watts at standby; it operates on 115-v., 60-cycle current. The instrument weighs 150 lb. and measures 15¾ by 21½ by 15 in.

High-Hardness Tool Bits, Blades Contain Approximately 13% Cobalt

A new series of cutting tools, having hardness of 66 to 68 Rockwell C and tensile strength better than 300,000 psi., has been announced by *Plew Tool & Metal Heat Treat*, Columbia City, Ind. Favorable hardness and toughness properties of the "Lucky 13" series are attributed to the cobalt content of about 13%, and a series of high and low temperature heat treatments.

Standard ground square tool bits come in sizes 3/16-in. square by 2-in. length up to 1 by 7 in. Standard ground flat tool bits range from ¼ by ⅜ by 3 in. to 1 by 1¼ by 6 in. Ground cut-off blades are available from 3/32 by ½ by 5 in. to 5/16 by 1 by 6½ in. Special sizes are made to order.

Stop Corrosion... Boost Stack Drafts, Save Time, Cut Costs with LUMNITE* REFRACTORY CONCRETE LININGS

Your steel stacks are fully protected against heat and corrosion when Lumnite Refractory Concrete linings are installed. When made with Lumnite and insulating aggregate, these linings boost drafts by keeping gas temperatures up. They resist attacks of condensate and sulphurous gases. Linings are jointless, allow no "breathing." Lumnite concrete thus adds years of service to old stacks, protects new stacks indefinitely.

Lumnite Refractory Concrete linings are easily installed. They are trowelled in place or "shot" by concrete gun over reinforcing mesh. Outage time for repairs is kept to a minimum because Lumnite linings reach service strength in 24 hours or less. Thus long service and easy maintenance give you time- and money-saving operation. For further information on Lumnite Refractory Concrete in stack linings, flues and other uses, write to Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

SPECIFY CASTABLES MADE WITH LUMNITE

Where suitable aggregates are not readily obtainable, tailor-made mixtures, ready for immediate use, are available. These factory-prepared mixtures of Lumnite and selected aggregates, when mixed with water on the job, may be cast into place for furnace door linings, arches, blast furnace pads, annealing furnace car tops and door linings. Special shapes can be cast in molds—ready within 24 hours. Castables made to meet specific temperature and insulation requirements are prepared by manufacturers of refractories and sold by their distributors.

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

MM-L-21

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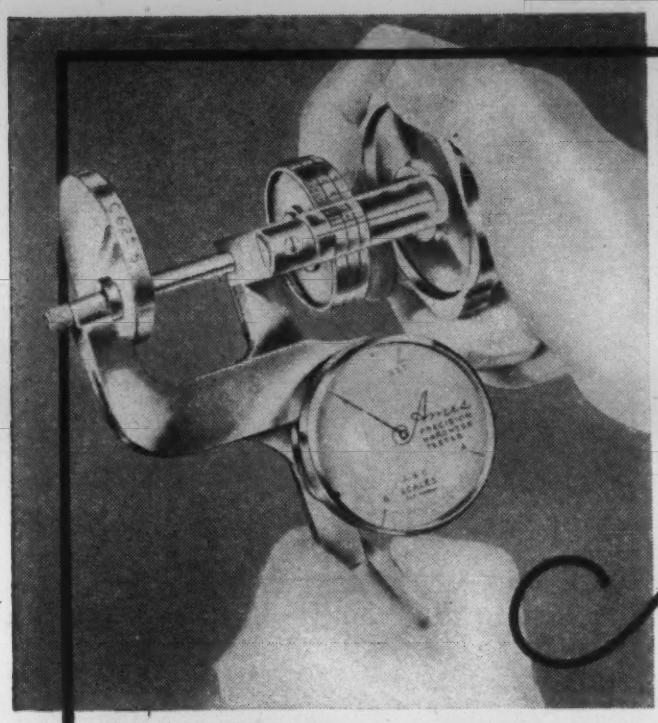

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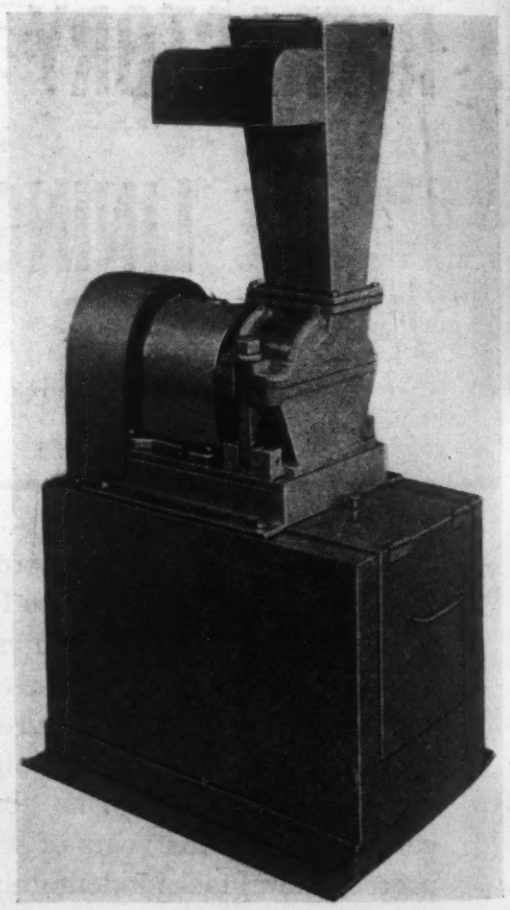
New Materials and Equipment

Plastics Granulating Machines Adapted to Serve Molding Units

Remodeling of two sizes of plastics granulating machines to adapt them for installation in connection with injection molding machines has been announced by *Cumberland Engineering Co., Inc.*, Providence, R. I.

The new machines, Nos. 0 and ½, feature a smaller motor in the base, V-belt drive and built-in, dust-tight material container.

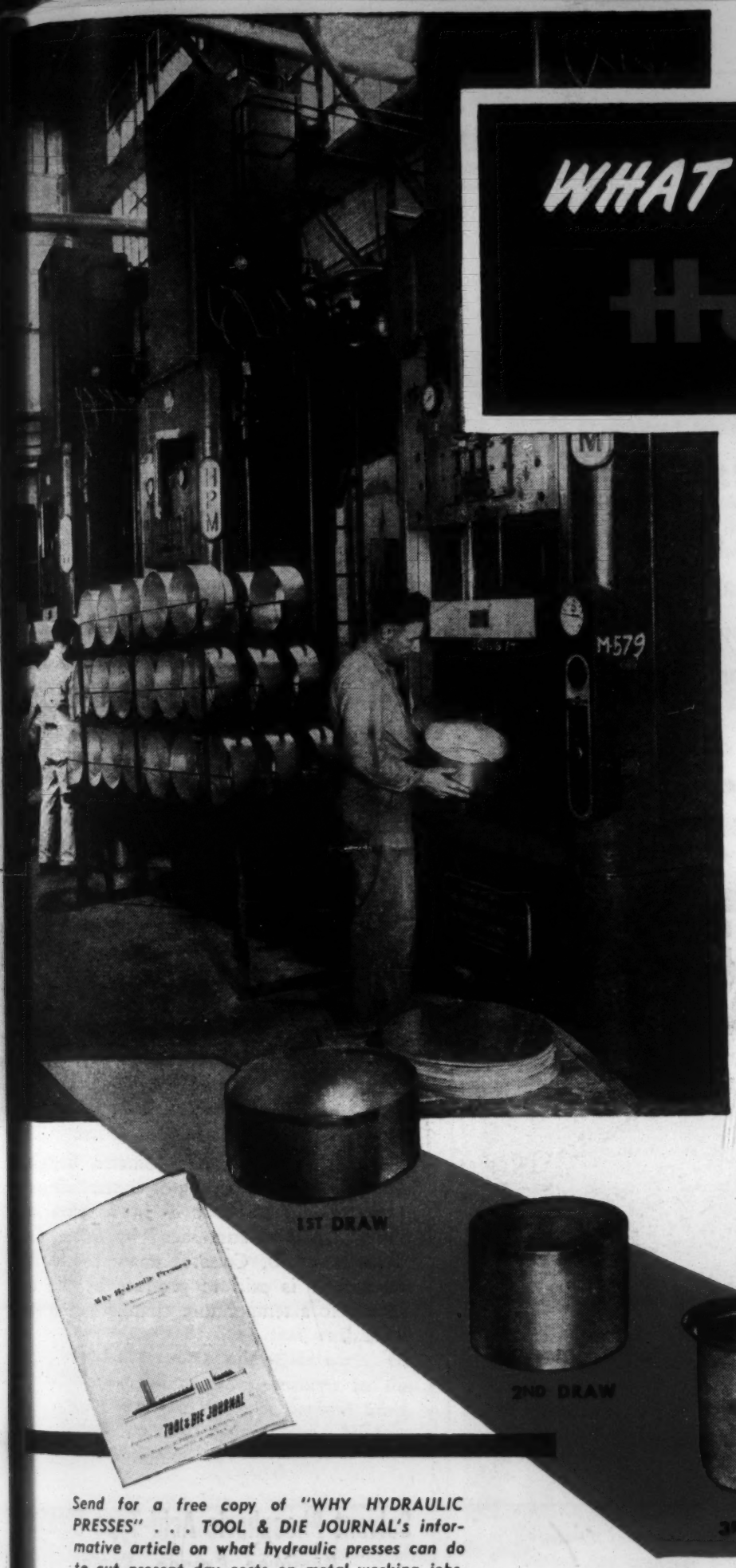
Such installations are being adopted by



Pictured here is the remodeled Cumberland No. 0 plastics granulating machine.

many operators because it permits them to trim parts and feed the sprues and runners directly into the granulating machines. This practice saves labor and handling of material to and from central grinding stations, and the possibility of mixing colors is avoided.

● An electrode holder which remains cool while operating up to 725 amp. on ⅜-in. electrodes has been announced by *Martin Wells, Inc.*, 5886 Compton Ave., Los Angeles 1.



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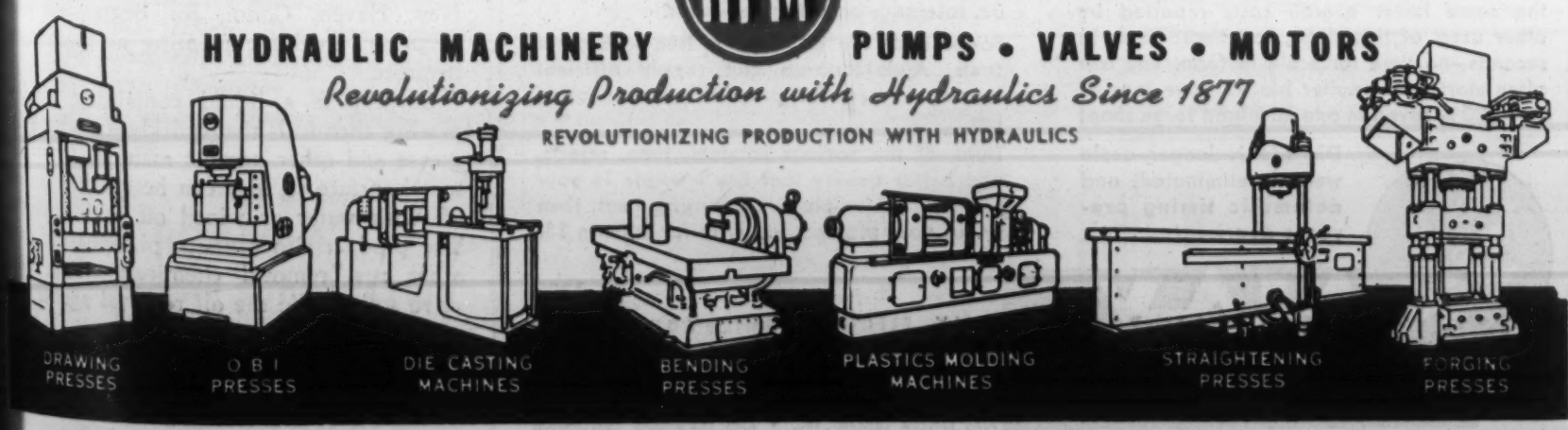

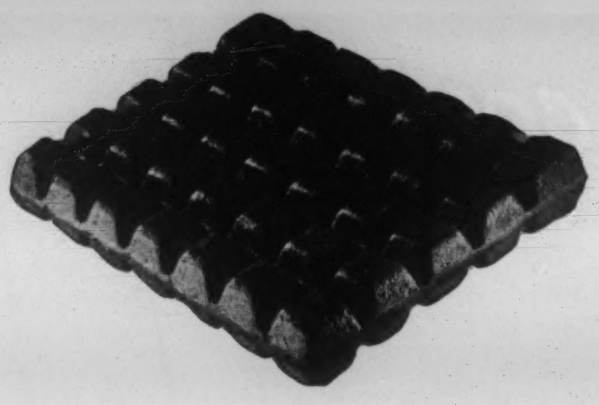

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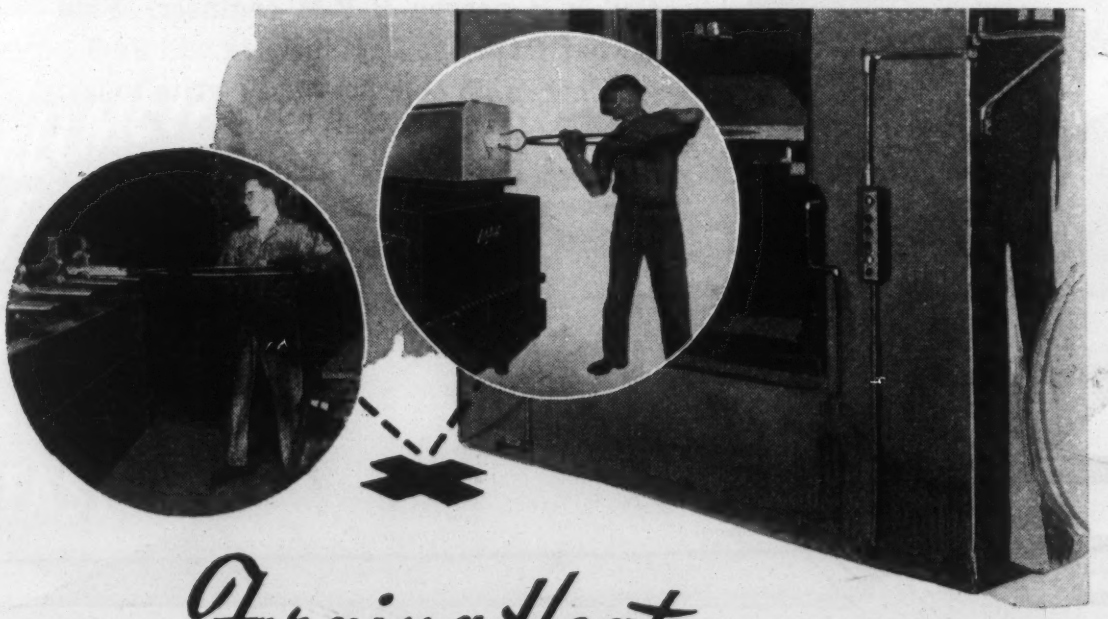
New Materials and Equipment

New Fibreglas-Silicone Rubber Gaske Can Be Used up to 500 F

A heat-resisting gasketing material con sisting of woven Fibreglas cloth coated wit silicone rubber has been developed b *Acushnet Process Co.*, New Bedford, Mas It is recommended for use up to 500 F.

In addition to heat resistance, advantage claimed for this material are: light weigh minimum thickness, and good strength an oil resistance. At the present time it i being used primarily as a gasket betwee the rocker box and rocker box cover i aircraft engines.

The material is now being furnished i only one thickness, that varying betwee 0.013 and 0.020 in. The Fibreglas clot itself weighs 6 oz. per sq. yd., and ha minimum breaking strength of 250 lb. pe in. on the warp and 200 on the fill.



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● A new radiation pyrometer, designe for indicating, recording or controlling tem peratures up to 4000 F in furnaces an kilns, has been announced by *Bristol Co* Waterbury 20, Conn. Known as the Py rovisor, it is said to produce a 99% re sponse to a temperature change within on second.

Solvent Phosphoric Acid-Type Cleaner Removes Grease, Scale

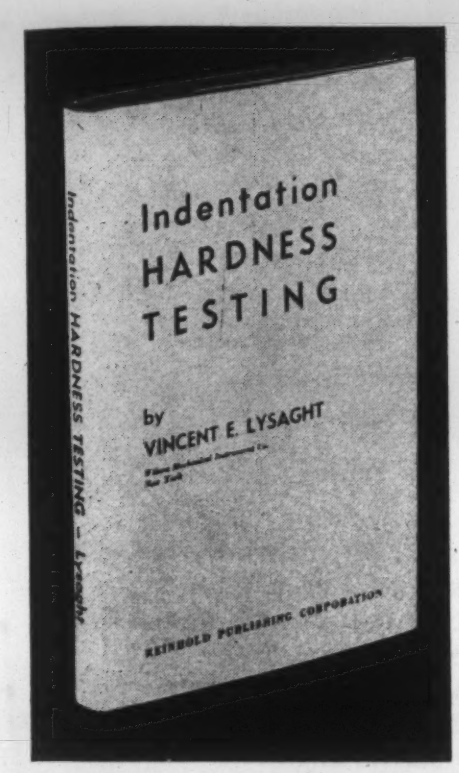
A new solvent phosphoric acid-type cleaner, Surprep, has been developed b *Enthone, Inc.*, Dept. MA, 442 Elm St New Haven, Conn., for degreasing and preparing steel for painting at room tem perature.

Surprep is a liquid containing oil-dis placing chemicals that quickly dislodge oil grease and other organic material from th metal surface so they can be quickly rinse off with water or wiped off with a cloth The product also contains phosphating and other rust removal chemicals which dis solve scale while the oil removal agents are operating.

The material can be applied by brushing or wiping. No toxic vapors are evolve during use of this cleaner.

"This book should help provide a clearer understanding of the fundamentals of the subject and may well inspire many to explore further into this useful branch of metallurgy and engineering."

—American Metal Market



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Useful, factual and based on up-to-date industrial research practice, this new book covers the many problems involved in the hardness testing of metals and other materials. It describes the instruments in most common use—the Brinell, Rockwell, Scleroscope and Diamond Pyramid, as well as those used for specialized types of hardness tests. The author evaluates the advantages and disadvantages of each test and gives complete specifications for each. He covers the recent advances in the field and the work of present hardness committees of the leading technical societies.

Whether you are a metallurgist, a testing engineer, a machine operator or a student, you will find much of value in this complete story of hardness testing. The more advanced student and research investigator will find sufficient theory to afford a comprehensive basis for practical hardness testing. The plan, scope and simplicity of language make the book admirably suited for a text in schools offering courses in metallurgy.

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Selecting materials, parts and finishes for use in product manufacture has become a highly specialized function performed by materials experts. These materials engineering men must keep up to date on the properties and applications of engineering materials — they must be thoroughly familiar with methods and equipment for changing or improving the properties of materials.

* * *

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- Railway equipment and rolling stock
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- Light machinery, instruments
- Electrical equipment and appliances
- Hardware, cutlery and tools
- Building equipment and products
- Process industries equipment
- Ordnance
- Ships, boats, marine equipment

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* * *

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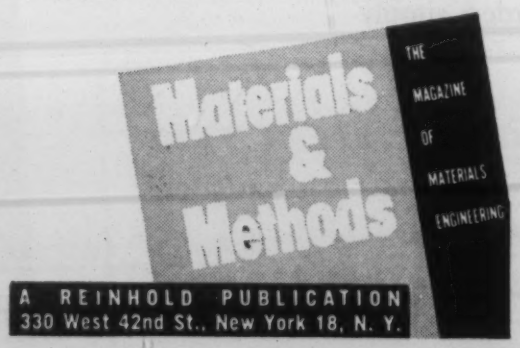
- Equipment and methods for joining materials



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EDITORIAL

A New Approach to Economics

For as many years as mass production has been a reality, one of the basic principles has been the use of the least expensive materials wherever possible. That concept still holds, but many engineers are following a new interpretation of the old rule.

Not so long ago there were only a few materials from which a choice could be made. There were iron, steel, bronze, brass, copper, lead, wood and, perhaps, a few other materials from which a choice could be made. As time passed, and our civilization and its requirements became more complex, variations were developed in each of these material groups and entirely new ones were produced, including such items as plastics and synthetic rubbers.

Generally, a new material or variation of an old one was developed to fulfill the requirements of one specific application. However, most of these materials could well be adopted for other products with benefit to both manufacturer and ultimate consumer. The taking of such steps is generally slow, or at least has been slow in the past, for in most cases the newer materials were more costly than the old. The cost factor showed their acceptance.

The new interpretation of an old concept of which we speak has to do with understanding that in many cases even though the newer materials are more costly, from a purchasing agent's point of view, they really can be much cheaper in the long run.

This is not meant to imply that a material or metal form should be discarded simply because it is old or because newer materials have been developed in its general field. We do suggest that periodically all materials used be reexamined to see if they are really doing the job they should do. One good source of help in making such evaluations is the file of reports made by service engineers. These will show the points of weakness in any product.

Your customers have a right to expect a definite, trouble-free life of any product they buy. The use of any but the best of materials for your specific application is not playing fair with the people on whom you depend for your personal and business existence. For example, you make valves for a specific industry. Valves are expected to last a long time without the need for frequent maintenance or replacement. Should your valve be designed to use an inferior material in any of its parts, its chances for long life are remote. A failure in service is costly to your customer. It is costly to you to make replacements. You will probably lose that customer.

Probably most products now in general use could be made of any one of several materials and by any one of several fabricating methods—but there is only one best combination. It is up to you to find that best combination for your product. And don't discard that best combination merely because it happens to cost more. The added cost may save itself many times over when your product finally goes into the hands of your customers.

T. C. Du Mond
Editor